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Province of Quebec, Canada

DEPARTMENT OF COLONIZATION, MINES AND FISHERIES

MINES BRANCH

HONOURABLE HONORÉ MERCIER, MINISTER; S. DUFAULT, DEPUTY-MINISTER;
THÉO. C. DENIS, SUPERINTENDENT OF MINES.

REPORT

ON

MINING OPERATIONS

IN THE

PROVINCE OF QUEBEC

DURING THE YEAR 1913.

QUEBEC
PRINTED BY E. CINQ-MARS,
Printer to His Most Excellent Majesty the King.

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PROVINCE OF QUEBEC

DEPARTMENT OF COLONIZATION, MINES AND FISHERIES.

To the Honourable HONORÉ MERCIER, M.L.A.,

Minister of Colonization, Mines and Fisheries,

Quebec, Que.

Dear Sir,—

I beg to submit to you the Annual Report of the Mines Branch for the past year.

This report, which has been compiled and written by the Superintendent of Mines, covers the year ending December 31st, 1913.

I remain, Sir,

Your most obedient Servant,

S. DUFAULT,

Deputy-Minister.

Quebec, May 15th, 1914.

PROVINCE OF QUEBEC

DEPARTMENT OF COLONIZATION, MINES AND FISHERIES

MINES BRANCH

Mr. S. DUFAULT,

Deputy-Minister of Colonization, Mines and Fisheries,

QUEBEC.

DEAR SIR,—

I have the honour to transmit herewith the Annual Report of the Mines Branch, on the Mining Operations, Mineral Production and Geological field work of the Province of Quebec during the calendar year 1913.

On February 23rd, 1914, a preliminary statement of the Mineral Production was published. This was mainly statistical, and the figures were given subject to revision. The present report, with final figures, supersedes the preliminary statement.

Yours very obediently,

THEO. C. DENIS,

Superintendent of Mines.

Quebec, May 15th, 1914.

NOTE

In the statistical tables, and in the review of the mining industry of the province during the year, the term "production" is synonymous to "quantity sold or shipped," and does not necessarily represent "output." The ore, and other mineral products remaining as "Stock on hand" at the end of the year, are not included in the production figures.

The ton used throughout is that of 2,000 lbs., except when specially mentioned.

The year referred to is the calendar year, ending December 31st, unless specially stated.

We endeavour to give values of the mineral products, raw or manufactured, as estimated at the point of shipment or at the pit-mouth—this, however, is sometimes difficult to obtain.

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MINING OPERATIONS
IN
THE PROVINCE OF QUEBEC
DURING THE YEAR 1913.

STATISTICAL REVIEW

According to the returns received by the Quebec Mines Branch, the value of the products of the mines and quarries of the province reached a total of $13,119,811 during the year ending December 31st, 1913. It is the highest annual production recorded to date and exceeds that of 1912 by $1,932,701, or a proportional increase of 17%.

A preliminary statement of the production was published in the latter part of February. The figures were given subject to revision, as, at that time, some dilatory producers had not yet sent in their returns.

The Mining Law is quite explicit in respect to sending in reports of production. Article 2163 of the Quebec Mining Law states that "Every owner of mining rights, whether he mines himself or by others, and every person working mines shall, during the first ten days of January in each year, furnish a sworn statement of his operations for the past year, mentioning the quantity of mineral extracted, its value at the mine, the quantity and value of the marketable product, and the number of workmen employed, as well as a list of the names of persons killed in working the mines."

As a rule, returns are made promptly. But a few belated reports usually delay the final compilation of the figures, and it is for this reason that a preliminary statement is issued so as to place the statistics before the interested public at as early a date as possible. Although not quite complete, the early statistical data are sufficiently near the truth to give a very good idea of the state of the industry. In 1913, there is a difference of 1.6% between the total of the early statement and the figures as finally compiled. In 1912, they differed by 1 ½%, and as a rule, the difference is less than 2%.

The table of production shows that the greater proportion of the total is made up of the value of the structural materials. They make up 63%. The products of metalliferous mines enter for

7½% only in the total. It is a slight increase as compared with the previous year, 6.09%, and quite an appreciable one as compared with 1911, when the proportion was only 3.17%. This increase is due solely to the further development of old districts, for we have yet no production to record from the northern fields. That these will eventually contribute to our mineral production, there is no doubt. Promising geological and mineralogical conditions exist in the Kienawisik lake region, whence discoveries of gold have been reported. In this connection, it may be mentioned that, in the Report of Mining Operations in the Province of Quebec for 1912, a report on the North-western part of the Province of Quebec, by Dr. Bancroft, was published, as well as some notes on the gold discoveries at Lake Kienawisik.

The following table gives the annual value of the mineral production of the Province of Quebec for the last ten years.

Year	Value
1904	$3,023,568
1905	3,750,300
1906	5,019,932
1907	5,391,368
1908	5,458,998
1909	5,552,062
1910	7,323,281
1911	8,679,786
1912	11,187,110
1913	13,119,811

We note that since 1904, we have an unbroken series of increases of each year over the preceding one. In ten years, therefore, the mineral production of the province has more than quadrupled. It is especially gratifying to note that the general business depression which prevailed during the greater part of the year does not seem to have affected the mining industry in our province. The general table of production shows that we record increases in all the main items. In fact, comparing the production of 1913 with that of the previous year, the Province of Quebec shows a higher proportional increase than any of the other provinces. Quebec's increase in 1913 over 1912 amounted to 17%; Ontario 12.5%; Nova Scotia 2%; British Columbia shows a decrease of 5½%.

TABLE OF MINERAL PRODUCTION OF THE PROVINCE OF QUEBEC DURING 1913

Substances	Number of Workmen	Salaries	Quantities	Value	Value in 1912
Asbestos, tons	2,909	$1,686,251	136,609	$3,830,504	$3,059,084
Asbestic, tons	.....	.....	28,473	20,346	23,358
Copper and Sulphur ore, tons	292	163,997	87,550	812,899	631,963
Feldspar, tons	6	1,379	74	1,554	2,200
Gold, ozs	25	8,335	738	14,794	19,924
Graphite, tons	73	45,195	103	9,620	50,680
Iron Ore, bog, tons	.....	.....	.....	.....	.....
Iron ore, titaniferous, tons	36	6,093	4,981	9,824	4,024
Kaolin, China clay	27	15,000	253	4,354	520
Magnesite	.....	.....	515	3,335	9,645
Mica, lbs	270	83,533	781,648	117,038	99,463
Mineral Water, gals.	21	4,587	77,313	31,728	39,854
Ochre, tons	44	19,529	5,987	40,868	32,010
Peat, tons	.....	.....	.....	.....	2,000
Phosphate, tons	5	205	360	3,506	1,640
Quartz, tons	4	800	900	2,363	418
Silver, ozs	10	3,687	36,392	21,791	14,591
Zinc and Lead ores, tons	59	35,500	335	7,370	.....
STRUCTURAL MATERIALS					
Brick, M	1,843	590,003	159,408	1.297,592	1,284,232
Cement, bbls	1,278	1,136,117	2,881,480	3,361,292	3,098,350
Flagstone	.....	.....	.....	.....	600
Granite	645	365,378	.....	496,588	358,749
Marble	209	108,154	.....	120,541	252,041
Lime, bushels	317	163,431	1,922,837	464,424	455,570
Limestone	1,414	747,418	.....	1,704,207	1,363,555
Sand	171	65,966	.....	405,750	170,600
Sandstone	10	370	.....	5,072	.....
Slate, sq	20	12,660	1,337	6,286	8,939
Tile, drain and sewer pipe, pottery, etc.	237	138,114	.....	326,165	203,100
	9,925	$5,401,702	.....	$13,119,811	$11,187,110

GEOLOGICAL FIELD WORK IN THE PROVINCE OF QUEBEC.

For geological field work, such as investigation of mineral districts, geological mapping, geological exploration, study of mineral deposits—the Quebec Mines Branch, for reasons of economy, has, to a great extent, to rely on outside geologists, such as University professors, who can dispose of some time during the summer. In the past, we have had investigations carried on in the Abitibi region; in the basins of the Bell and Nottaway rivers; in Lake Timiskaming; in the Gaspé peninsula; in the Chibougamau region; on the iron ore deposits of the Province of Quebec. Reports have been issued of these investigations and explorations.

But, during the summer of 1913, an event of world-wide importance in geology was taking place in Canada—the Twelfth Meeting of the International Geological Congress—and practically all Canadian geologists worked to the utmost of their powers to make this reunion a success. No field geologists could therefore be secured for regular field-work, and, moreover, the Superintendent of Mines had to devote a considerable part of his time to the work of the Twelfth Congress, as member of the Executive Committee.

Our Report this year will not contain results of geological field-work, as it has for several years past. Nevertheless, late in the season, Dr. Bancroft began an investigation of the copper deposits of Weedon and Stratford townships. He spent three weeks in the field, and the work will be continued during the coming summer.

The importance of such field-work does not need to be emphasized. Its main object is to call attention to the possibilities of our mineral resources, and also to protect the investing public against exaggerated statements and frauds, by giving as wide publicity as possible to accurate descriptions of our mineral districts, their geology, their possibilities. That this has been one of the features of the Quebec Mines Branch will be realized by referring to the Annual Reports and to the Special Reports published in the last few years, where will be found plain statements of observed facts, accurate descriptions of mineral occurrences, prospects and mines in such districts as Keekeek lake, Kienawisik, Chibougamau, Opasatica lake, Fabre township, and numerous others.

If the public would avail itself more of the information at its disposal in the Quebec Mines Branch, published as well as unpublished, as to the possibilities of mineral districts, instead of being lured by plausible promoters into buying stock certificates in mining ventures of which they are, technically speaking, in absolute ignorance, a great deal of disappointment and heart-burning would be spared.

Mining enterprises, when reduced to a business basis, with the right assistance and advice, are, on the whole, quite as safe as farming, commercial and industrial enterprises. But to be legitimate mining enterprises, they must be based on actual knowledge, on observed facts, and be devoid of the imagination which makes up the greater part of the unscrupulous promoter's prospectuses.

For one thing, careful discrimination should be made by the investor between prospecting or developing ventures, and the exploitation of producing mines, or mines sufficiently developed, with ore blocked out to ensure success. Searching, prospecting and developing are naturally hazardous. When successful, the returns from such investments are very large—but the proportion of failures to successes is very great. Investments of this nature are certainly not for the small savings, which should always remember that the risk is proportionate to the returns. If the investor expects large returns, he has to take risks of losses. As many know to their cost, there are stocks, mining and others, which are very easy to buy, but extremely difficult to sell at any price.

It may also be mentioned that the Federal Department of Mines has published, and is publishing every year, a vast amount of information, concerning the mineral resources and the geology of the Province of Quebec, which can be drawn upon by the interested public. The two branches of the department, the Geological Survey and the Mines Branch, have their headquarters in Ottawa, and their publications can be obtained on request to the Directors. In 1912 and 1913, the Ottawa Mines Branch was carrying on the following investigations in the Province of Quebec:—

Building Stones—by Dr. W. A. Parks.

Feldspar and Phosphate—by H. S. de Schmid.

Investigation of Iron Sands of Natashquan—by G. S. McKenzie.

Investigation of Peat Deposits—by A. Anrep.

The Geological Survey, during the last two years, have done field work, topographical and geological, in the following districts:—

The Serpentine belt (Orford and Thetford maps)—by Robert Harvie.

Abitibi District (Kewagama Lake map area)—by Morley E. Wilson.

Lake Evans and Broadback river—by H. C. Cook.

The Clay Deposits of Quebec—by J. Keele.

It is moreover hoped that the Geological Survey will soon be in a position to take up a systematic mineral and geological exploration of the Northern territory of New Quebec.

The Quebec Mines Branch will send two parties in the field during the summer of 1914.

One of these will be under the direction of Dr. Bancroft, who will make an examination of the copper-bearing districts of the Eastern Townships.

Another party under Professor E. Dulieux, of Polytechnic School, will make a special study of the road materials of the province. This work will consist in an investigation of the quarries, rock outcrops, gravel and boulder deposits favourably situated to be used as road metal or for paving blocks. It will, of course, comprise tests for abrasion, crushing strength, binding qualities, etc.

Taken in conjunction with the active movement for good roads which is at present so general throughout the province, this investigation would be most useful, for, so far, the data which we possess on the subject are so scattered and indefinite, as to be almost valueless.

CHEMICAL LABORATORY.

The Quebec Mines Branch maintains at Polytechnic School, 228 St. Denis Street, Montreal, an up-to-date, well equipped assay and chemical laboratory for the convenience of the interested public. Analyses and assays, determinations of mineral specimens, and tests of various kinds, of ore samples and materials found within the boundaries of the Province of Quebec are made in this laboratory

at prices which are extremely low for the high-grade work done. The laboratory has been installed for the sole purpose of aiding the development of the mineral industry of the Province of Quebec. Prospectors and all persons interested in the Quebec mineral resources are cordially invited to avail themselves of the facilities offered. The tariff in force for the analysis and assay of various substances is given further on, and it will be realized that the fees are very low, as the high competence of the chemists insure results of undoubted reliability.

During the year ending December, 1913, the Provincial Laboratory effected 835 analyses and assays, as follows:—

Gold and silver, 214; chrome, 2; cobalt, 1; alumina, 5; copper 26; tin, 1; graphite (carbon), 9; iron, 105; magnesia, 20; lime, 21; phosphorus, 24; manganese, 4; molybdenum, 5; nickel, 4; platinum, 2; lead, 4; potassium, 2; soda, 2; silica, 36; sulphur, 34; titanium, 55; zinc, 2; carbonic acid, 1; ash, 6; chlorine, 3; moisture, 23; oxygen (in water), 6; combustions, 36; radioactivity, 5; dessications, 7; hardness of water, 5; density, 3; crushing tests, 4; fusion tests, 9; water purifying tests, 2; magnetic concentrations, 31; identification of minerals, 31; qualitative tests of metals, 85.

PROVINCE OF QUEBEC
GOVERNMENT ASSAY LABORATORY

(Under the direction of the Department of Mines of the Province of Quebec as an aid to the development of the mineral resources.)

TARIFF OF FEES FOR ASSAYS AND ANALYSES

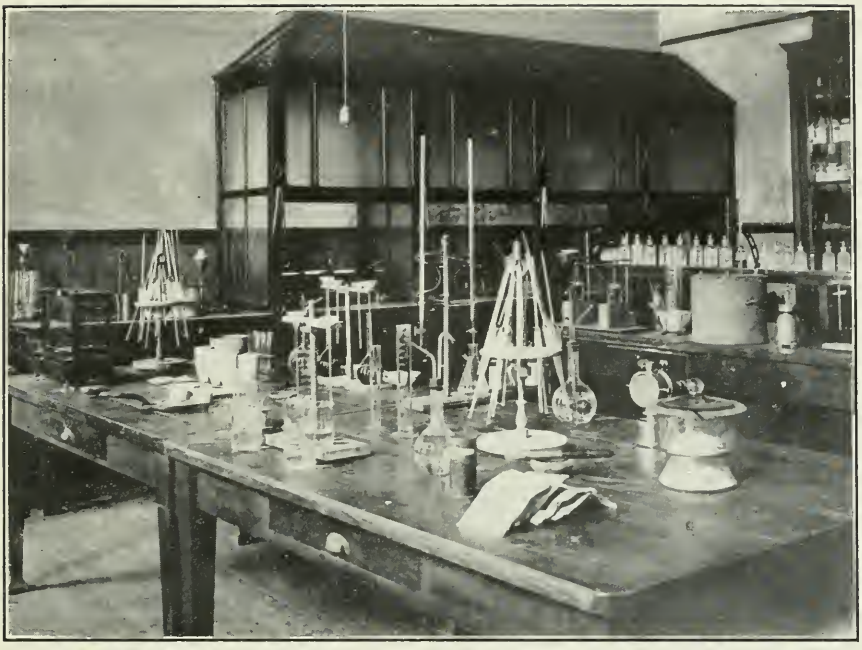
DETERMINATIONS	Less than 5 samples. Each:	For 5 samples or more. Each:
	$ Cts.	$ Cts.
Moisture	0.25	0.25
Combined water	0.50	0.50
Gold and Silver	1.00	0.90
Silica, Copper, Iron. Iron, in titaniferous ore; $2.00. — 1 constituent	1.00	0.90
Silica, Copper, Iron. Iron, in titaniferous ore; $2.00. — 2 constituents in same sample	1.75	1.50
Graphite, Alumina, Lime, Magnesia, Sulphur, Lead, Nickel, Cobalt — 1 constituent	1.50	1.35
Graphite, Alumina, Lime, Magnesia, Sulphur, Lead, Nickel, Cobalt — 2 constituents in same sample	2.50	2.25
Antimony, Zinc, Manganese, Chromium, Titanium, Arsenic, Phosphorus, Platinum, Bismuth — 1 constituent	2.00	1.80
Antimony, Zinc, Manganese, Chromium, Titanium, Arsenic, Phosphorus, Platinum, Bismuth — 2 constituents in same sample	3.50	3.15
Commercial analysis of an iron ore, comprising determination of silica, iron, phosphorus, titanium and sulphur	6.50	5.85
Commercial analysis of a limestone or cement, comprising: silica, lime, iron, alumina, magnesia, and sulphuric acid	6.00	5.40
Commercial analysis (proximate analysis) of a fuel, comprising: ash, volatile combustible, fixed carbon, moisture	3.00	2.70
Calorific power of a fuel	1.50	1.35
Radioactivity of a mineral	1.00	0.90
Radioactivity of a mineral water	2.00	1.80

Determination of Minerals.—For a nominal fee of 25c for each sample, the laboratory will make determinations of ores and minerals, provided rapid tests will allow it, and issue a report on probable contents and commercial value of specimens and samples.

Terms.—Money in payment of fees, by registered letter, postal notes or orders, must invariably accompany the samples, in order to insure prompt return of certificate.

Professor E. DULIEUX,
In charge of Laboratory,
No. 228 St. Denis St.,
Montreal.

Copies of this circular may be obtained in French and English.



PROVINCIAL GOVERNMENT LABORATORY, MONTREAL.

PROVINCIAL GOVERNMENT LABORATORY, MONTREAL.—Assay room.

INTERNATIONAL GEOLOGICAL CONGRESS.

The International Geological Congress, after accepting the invitation which the Canadian Government, the Royal Society and the Canadian Mining Institute had tendered it at the previous meeting in Sweden in 1910, held its twelfth session in Canada during the month of August, 1913. The meetings of the Congress are held every three years in different countries, throughout the world, and its object is to advance the knowledge of the earth, both in the field of pure geological science, and in its application to the arts and industries, more particularly to the development and the rational exploitation of the mineral resources. The members who take part in it comprise practically all the leading geologists and mining engineers of the world. The governments of the civilized countries are represented by official delegates. The methods by which the Congress endeavours to accomplish its aim are:—Meetings, publications, international committees, excursions and prizes. The first meeting of the International Geological Congress was held in Paris, in 1878, at the time of the International Exposition, and since then, sessions have been held in Germany, England, Russia, United States, Austria, Italy, Switzerland, Mexico, Sweden. It was therefore quite an honour for Canada to have its invitation accepted, and for eighteen months before the date set for the Congress, a Canadian Executive Committee, under the presidency of Dr. F. D. Adams, worked incessantly to the organization of the meeting, excursions and publications. The expenses of the Congress were met by generous grants from the Federal Government, the Provincial Governments of Ontario, Quebec, British Columbia, and Nova Scotia, and from some of the large Canadian industrial corporations.

The sessions of the Congress were divided into three parts, as follows:—

(1) Excursions in Eastern Canada, Maritime Provinces, Quebec and Ontario, from July 13th to August 6th.

(2) Meetings of Congress at Toronto, August 7th to 14th.

(3) Excursions in Western Canada and Yukon, August 15th to September 22nd.

The members of the Congress numbered 982, of whom about 500 were in attendance at Toronto. There were 53 countries represented, practically all of which had appointed official government delegates.

The excursions before and after the Congress are always the outstanding features of the sessions, and, in Canada, they were exceptionally well attended.

In the Province of Quebec itself, seven excursions had been organized, lasting from one day to six days each, which were designated as follows, on the official programme:—

A1. Quebec, Levis and Gaspé peninsula.
A5. Asbestos and chrome deposits of Eastern townships.
A6. Anorthosite region of Terrebonne county.
A7. The Monteregian Hills.
A8. District of Lièvre and Gatineau rivers.
A10. Post-pliocene deposits of Montreal and Ottawa.
A11. Ordovician formations of Montreal and surroundings.

The number of participants in each of the excursions varied between 25 and 80. Special trains with sleepers and dining cars were chartered in each case, and these excursions offered a heretofore unequalled opportunity to draw the attention of distinguished foreign technicians, not only to our mineral resources and their possibilities, but also to all our other natural resources.

LEGISLATION.

An important amendment to the Mining Law was passed at the last session of the Quebec Legislature. By this measure, the price of the mining land was reduced from $20 and $10 an acre, according to its distance from a railway line, to $5, irrespective of its location.

The prices of $20 and $10 an acre, as the price of mining concession, were adopted in 1907. Although these rates were higher than in the other provinces, this was counteracted by the fact that our system of mining licenses allowed liberal time, at a yearly rental, to search and develop; and the high prices for the concession did not need to be paid before the mineral deposit had been sufficiently proved. This principle is excellent in theory, but it is unfortunate-

ly a fact that it is difficult to convince capitalists that yearly mining leases are practically as secure a title as freehold, and capital is much more willing to take risks in developing a mining property of which a clear Crown title has been issued, than on prospects of which the discoverer has only a yearly lease. And as the prices of $20 and $10 were not within the reach of the average prospector, especially after having spent money in opening up the deposit, the amendment reducing the price to $5 for superior minerals and $3 for inferior minerals was introduced and adopted, as being an aid and an inducement to the prospector.

In Ontario, which is the leading province in point of mineral production, the prices for the purchase of mining land are $3 and $2, according as to whether surface rights have been previously alienated or not. In British Columbia, which, until lately, was the leading mining province, the Crown grant, or patent, to mining lands, is issued after a certain amount of development work has been done, and no cash payment to the Crown is required, the output being subject to a royalty when the mine produces.

METEORITES.

In the "Ottawa Naturalist" of June 4th, 1906, the following description was published of the meteorite found in 1904 at Chambord. The examination of the meteorite was made by Mr. R. A. A. Johnston of the Geological Survey, who also wrote the article reproduced here.

THE CHAMBORD METEORITE.

Some time during the season of 1904, a mass of iron was picked up in a field about two miles from the village of Chambord (latitude 48° 35′ N.; longitude 73° 8′ W.) county of Lake St. John, Province of Quebec. It was secured by Mr. J. Obalski, Superintendent of Mines, Quebec, and by him kindly loaned to the Geological Survey Department for purposes of examination. It is an irregularly shaped block, having a length of 18.9 cm., a thickness of about 8.9 cm., and a width varying from 10.1 cm. to 15.5 cm., and a weight of about 6.6 kilogrammes. The surface of the speci-

men has unfortunately to a considerable extent been marred by chisel and hammer marks made in attempts to cut up the iron. The greater portion of the original crust has been scaled off by prolonged weathering, and its place taken by a thin coating of dark brown rust; that portion of the crust which is still remaining is smooth, with a dull enamel-like lustre, and has brownish-black color; the surface is possessed of the usual pittings found on meteoric irons; some of these are broad and shallow while others again are small. A trough-like depression extends along one side of the specimen, the bed of which is more or less jagged, as if a piece had been detached during the meteorite's flight through the atmosphere. Over a considerable area of the specimen, a natural etching is visible, sometimes as coarse furrowings, and at others as minute ridges. Etching of a polished surface develops the Widmannstatten figures in moderately coarse outline, the general design indicating an octahedral structure; this iron, therefore, belongs to the "Medium Octahedrites" (Om) of Brezina's system of classification. Schreibersite appears in considerable abundance as very thin lamellae disposed between the kamacite plates: in the trough-like depression previously referred to, two small nodules of troilite are exposed in section; they measure approximately 13 mm. in diameter and exhibit a series of fine parting lines running in parallel position. This iron has not yet been subjected to chemical analysis.

REPORT OF THE FALL OF A METEORITE AT MONTMORENCY FALLS, QUE., ON DECEMBER 15TH, 1913.

The following report was kindly furnished to the Quebec Mines Branch by Mr. Gerald M. Massey, who is in charge of the meteorological station at Montmorency Falls:—

"At about 6.50 p.m. on the 15th of December, 1913, a meteorite was seen travelling overhead, with a trajectory from the east towards the North-west with great speed. It appeared to fall to the ground somewhere on the east side of the Montmorency river.

"When my father, Mr. W. M. Massey, informed me that he had seen a meteorite fall in the locality, I lost no time in making en-

quiries of other eye-witnesses of the phenomenon, and their descriptions all agree in the main points, viz:—

"The meteor first appeared overhead, travelling from the east, like a ball of glowing heat, which sped towards the north-west with great rapidity, increasing to the eye in size and luminosity as it approached the earth.

"The event occurred in almost calm air. The sky was clear except for a few low, fleecy clouds on the eastern horizon, above which the moon was rising brightly, being then just past the full, and the night was quite light, and objects at a considerable distance were clearly discernible.

"When the meteorite was within about two hundred feet of the ground, it burst into fragments like a bombshell, with a crackling noise, which has been compared to the crackling of electricity.

"The fall of the meteorite occupied several seconds, and when all trace of light had vanished, a dark, opaque mass of some size was seen, still continuing on its track to the ground.

"The explosion of the meteorite illuminated the surrounding country, like the glare of a barn on fire, and a long train of meteoric dust remained for some time in the wake of the meteor.

"It is very doubtful if any fragments of the meteor could be located, although the point where the meteorite appeared to fall was accurately determined. A heavy fall of snow occurred on the night of the 16th, which, no doubt, would cover up any fragments for the present."

ACCIDENTS IN MINES

During the year 1913, there were 8,611 persons employed in the mines, quarries, clay-pits and concentrating mills of the Province of Quebec. This number is not the actual number, which was somewhat higher, but it is a reduction to a basis of 300 days work per man per year, from the actual number of days work performed, which totalled 2,583,673. Our return forms call for the average number of men employed—the number of days in operation, and the amount of salary paid during the year—and it is believed that the above figures are comparatively accurate. The total sum paid in wages during the year amounted to $5,401,702, or an average of $626 per person per year. This may perhaps appear low, but it must be considered that all our mines and quarries are situated in the settled parts of the province, where unskilled labour commands a much lower rate than in the average northern mining camp, and also that a certain proportion of the employed are signal-boys in the asbestos open pits, girls in the mica trimming shops, and in the asbestos sorting sheds.

Throughout the year, sixteen deaths occurred through accidents in mines, quarries, clay pits, in the province. Taking the basis of 8,611 persons employed, this gives a general proportion of 1.86 per 1,000 men employed. In the mines proper, asbestos, copper, graphite, mica, etc., the proportion was much higher; of 3,444 men, 11 were killed, or a proportion of 3.19 per 1,000 men employed. In the quarries proper, clay pits, brick-yards, etc., there were 5,167 persons employed, 5 of whom were killed, or a proportion of 0.97 per 1,000 employed.

The following table indicates the distribution of the persons employed in the mining industry during the year 1913:—

PERSONS EMPLOYED IN MINES, QUARRIES, CONCENTRATORS AND MINERAL MILLS IN THE PROVINCE OF QUEBEC IN 1913.

Mines, Quarries and Mills	Number of Days Labour	Number of Men Calculated on 300 Days
Asbestos, (quarries and mills)	832,852	2,776
Copper and Pyrite (mines and concentrators)	84,141	280
Mica, Graphite, Phosphate	76,304	255
Ochre	10,930	36
Mineral Waters (springs and works)	4,141	14
Chrome, Titaniferous Ore, Zinc, Lead, etc.	24,882	82
Pottery, Feldspar, Kaolin, Quartz (pits and mills)	80,700	268
Cement (quarries and mills)	466,470	1,555
Limestone { quarries and kilns	428,794	1,191
Limestone { dressing works at quarries		238
Granite	188,257	628
Slate, Marble and Sandstone	63,895	214
Building Sand (pit and river)	35,910	119
Brick (clay pits and brick yards)	286,397	955
	2,583,673	8,611

FATAL ACCIDENTS.

There were 14 accidents throughout the year, which caused the death of 16 persons. Of these fatalities, 10 occurred in the asbestos mines, which are all worked open-cast, 5 in stone quarries, and 1 in underground workings.

By special arrangement with the Attorney General's Department, all the inquests held on fatal accidents occurring in mines, quarries and mineral mills are now attended by a technical officer of the Mines Branch (either the Superintendent of Mines or his assistant). In April, 1913, the coroners of the various districts throughout the province were instructed to advise the Mines Branch by telegram or telephone of the time and place of such inquests.

The fatal accidents were due to the following causes:—

Shaft accidents	1
Explosives	2
Falls of ground	4
Mills	1
Miscellaneous	8

Of the miscellaneous accidents, the most fruitful cause was falling to the bottom of the asbestos pits from various heights on the sides, which is accountable for 4 victims; 3 were killed through cable-derrick accidents; 1 was struck by a wire cable in a stone quarry.

FATAL ACCIDENTS

Date	Mine or Quarry	Name of Proprietor	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
Jan. 30	Jacobs Asbestos Mining Company	Jacobs Asbestos Mining Company	A. Trépanier	17	Bell boy	Fatal	Fell into pit.
" 30	" "	" "	E. Bédard	15	"	"	Fell into pit.
Feb. 27	Canada Cement Co. Ltd., Plant No. 2.	Canada Cement Co.	Giov. Vasello	26	Laborer	Fatally crushed	Was precipitated 30 ft. to bottom of pit.
Mar. 6	Bell Asbestos Mines	Bell Asbestos Mines	Jos. Daigle	36	Pit Laborer	Skull fractured	Iron weight fell on his head.
" 18	Argenteuil Granite Co., Chatham Tp, Quarry	Argenteuil Granite Co.	Horm, Fréchette.		Quarry foreman	Crushed by stone	Large block of stone rolled over him.
April 8	Pit No. 9	Black Lake Asb. & Chrome Co. Ltd.	Tuchym Gresnik.	32	Laborer	Injuries to head	Premature explosion.
" 15	Johnson's Co.	Johnson's Co.	Georges Goulet	47	Laborer	Skull fractured	Struck on head by falling stone.
Aug. 1	B. & A. Asbestos Co	B. & A. Asbestos Co.	T. Kazarichruk	47	Miner	Neck broken	Fell 80 ft.
" 5	Canada Cement Co. Ltd.	Canada Cement Co.	H. Stefanski	43	Laborer	Burnt and bruised about head	Premature explosion of dynamite.
" 9	British Can. Mines, Black Lake	Asbestos Corporation of Canada	Philippe Couture	37	Driller	Fatal	Fell from derrick box.
Sept. 23	King's Mines	" "	Sam. Guillemette	25	Pit miner	"	Fell into pit.
Sept. 23	"	" "	Henri Marcoux	23	"	Skull fractured	Fell into pit.
Nov. 11	McDonald Mine	East Canada Smelting Co.	W. D. MacLean	44	Shift boss	Neck broken and skull crushed	Caught his head riding on loaded skip.
" 21	Standard Lime Co. Ltd.	Standard Lime Co.	Jean Ls. Mayer	30	Miner	Head bruised	Head struck by stone.
" 22	Beaver Mine	Asbestos Corporation of Canada	O. Boissonneault	43	Mill oiler	Blow on head	Rising too quickly, struck head against pulley.
Dec. 18	Standard Granite Quarry	Standard Granite Quarries Co. Ltd.	Dom. Dellanoce	23	Laborer	Internal injuries	Struck by derrick rope in stomach.

On January 30th, A. Trépanier and E. Bédard, two signal boys, whose duty it is to act as intermediary between the hoist-man of the cable derrick and the box loaders at the bottom of the pit, were recklessly wrestling in play, on the edge of the pit of the Jacobs Asbestos Mining Co., Thetford Mines; they fell against the guard rail, which gave way, and they were precipitated to the bottom of the pit, being killed instantly.

On February 27th, Giovanni Vasello, a laborer employed at the quarry of the Canada Cement Company, Longue Pointe, Montreal, was prying down some rock from a face of the quarry, when the rock shelf on which he was standing gave way, and he fell thirty feet, the rock rolling over on him and crushing him to death.

On March 6th, Jos. Daigle was working in the pit of the Bell Asbestos Mine, when an iron weight which was added to the lower block of a cable derrick as make-weight, fell on his head, fracturing his skull.

On April 8th, Tuchym Gresnik, a laborer of the Black Lake Asbestos & Chrome Co., was helping to load a hole, when a small stone fell into the drill hole, and jammed about half way down. The foreman in endeavouring to dislodge it, with the help of a wooden tamping stick, gave a jerk which set off the charge, killing Gresnik, and injuring four others.

On April 15th, in the pit of Johnson's Company, Thetford Mines, a large piece of rock loosened from the side of the pit, probably through action of frost, and falling, broke into several pieces, a flying fragment striking George Goulet, fracturing his skull.

During the months of March and April, owing to the thawing weather, loose rocks are more liable to drop off the sides than at other times, and extra precautions are taken by operators. In the case of the Johnson pit, the sides of the pit had been scaled and cleaned on the 14th, the day before the accident.

On August 1st, F. Kozarichuk, at the B. &. A. mine, at Robertsonville, kept hold of a loaded box of rock after signal had been given to hoist by the cable derrick. He was raised to a height of

about 75 feet, and before signal could be given to lower, he fell from that height to the bottom of the pit.

On August 5th, at the Canada Cement Co.'s quarry, Montreal, seven big blasts of three tons of dynamite each were being loaded. In one of the drill holes, 60 feet deep, 6 inches in diameter, chambered at bottom, 1,500 lbs. of 60% dynamite had been lowered, and was being spread by means of a log weighing 40 lbs. at the end of a rope. On pulling out the log, it became fast in the hole about half-way up. A slight jerk to loosen it was followed by the explosion of the charge, killing H. Stepanski, and wounding four others.

The man in charge of the big blasts had been doing this sort of work for twenty years. The cause of the premature explosion could not be ascertained. It may have been due to exudation of the dynamite, leaving a trail of nitro-glycerine on the sides of the hole; or to a stone becoming detached from the side of the hole by the jerk given to the tamper.

On August 9th, at the British Canadian Mine at Black lake, Philippe Couture, a driller, came up from the bottom of the pit in a derrick box, contrary to regulations. One of the ropes of the box gave way at a height of 125 feet, and Couture fell that distance to the bottom of the pit.

On September 23rd, at the King's mine, two scalers were cleaning the side of the pit, when the shelf of rock projection, on which they were standing, gave way, carrying them to the bottom of the pit. They were Samuel Guillemette and Henri Marcoux.

On November 11th, W. D. MacLean, shift-boss of the East Canada Smelting Co., contrary to orders and regulations, was riding up the incline on a loaded skip. His head caught on a rock projection in the shaft, broke his neck and fractured his skull.

On November 21st, J. L. Mayer was killed by a flying rock, from a blast, at the quarry of the Standard Lime Company, Joliette, P. Q.

On November 22nd, Odila Boissonneault, an oiler in the mill of the Beaver Mine, at Thetford, was killed by his head coming

in contact with a pulley, it was supposed. No one witnessed the accident.

On December 18th, at the Stanstead Granite Quarry, D. Dellanoce sustained injuries through a derrick rope flying back, owing to the sheave pin breaking. He died 48 hours afterwards.

NON-FATAL ACCIDENTS.

There were 181 non-fatal accidents reported at the Mines Branch. During the previous year, only 53 advices of non-fatal accidents were received. Of course, the two numbers cannot be compared, except to draw the conclusion that the returns were more complete in 1913 than in 1912. In fact it is thought that practically all the accidents entailing incapacity to work for ten days or more were reported to the Mines Branch.

The non-fatal accidents can be analyzed as follows:—

Shaft accidents	3
Explosives	15
Falls of ground	8
Accidents in mills (machinery)	11
Miscellaneous	144

Of the miscellaneous accidents, by far the greater proportion are wounds received while loading or moving rocks. About 50 are registered under this head, such as crushed fingers, injuries to feet, legs and hands. Flying and detached rocks from the sides of the open cast pits of the asbestos mines were responsible for 21 non-fatal accidents. Accidents due to cars and tramways number 16. The balance of the miscellaneous accidents are due to causes which cannot easily be classified under general headings.

The tabulation of the non-fatal accidents is given as follows:—

NON-FATAL ACCIDENTS

Date	Mine or Quarry	Name of Proprietor	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
Jan. 10	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Edward Davis	49	Laborer	Contusion, left leg	Piece of rock rolled on his leg.
" 10	"	" "	Joseph Provencher	19	"	Contusion, right leg	Fell against a large rock.
" 13	Weedon Mine	East Canada Smelting Co.	Joseph Fontaine	20	Miner	Badly crushed	While picking loose rock.
" 14	British Canadian Mines	Asbestos Corporation of Canada, Ltd.	Alonzo Lafrance	17	Cyclone feeder	Membrane of right eye injured	Fell against a suspended hook.
" 15	Canada Cement Co. Ltd.	Canada Cement Co. Ltd.	G. Foshook	40	Quarryman	Crushed foot	A slide of rock fell on his leg.
" 22	Granite Quarry	The Laurentian Granite Co. Ltd.	Ludger Lamarche	18	Laborer	Bruised	Slipped and fell down 15 feet, bruising himself.
23	British Canadian Mines	Asbestos Corporation of Canada, Ltd.	Lerkey Bomker	25	"	Broken jaw	Slipped between two timber derricks.
" 29	Black Lake Chrome & Asbestos Co.	Black Lake Chrome & Asbestos Co.	Arthur Gagné	21	"	Foot blown off	Explosion occurred when drilling for a block hole.
Feb. 7	Jacobs Asbestos Mining Co.	Jacobs Asbestos Mining Co.	T. McElraevy	40	"	Fracture of skull	Iron block fell from a height of 50 feet.
" 7	Delson Jct. Plant	National Brick Co. of Laprairie, Ltd.	John Burville	.....	"	Cut on leg	Struck by piece of rock.
" 8	King's Mines	Asbestos Corporation of Canada Ltd.	Philibert St. Laurent	23	Miner	Right leg broken	Slipped on ice and broke his right leg.
" 10	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Médéric Roberge	29	Laborer	Wound, left leg	Piece of rock rolled on his leg.
" 14	King's Mine	Asbestos Corporation of Canada Ltd.	F. St. Hilaire	64	Miner	Right foot injured	One stone rolled on his right foot.
" 14	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Alphonse Poirier	20	Tinsmith	Wound finger	Hammer striking the end of finger.
" 20	Canada Cement Co. Ltd.	Canada Cement Co. Ltd.	J. Aubin	36	Laborer	Bruised hip	Hit by bucket being lowered into quarry.
" 22	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Adélard Gervais	45	"	Contusion of leg and foot	Piece of rock slipped down from the pile.
" 24	B. & A. Asbestos Co.	B. & A. Asbestos Co.	Arthur Mercier	30	Fireman	Left hand and fore-arm burnt	Gasoline explosion.
" 28	Canada Cement Co. Ltd.	Canada Cement Co. Ltd.	D. Tremblay	50	Laborer	Head slightly cut	Struck by wheel when hooking chain on bucket.

NON-FATAL ACCIDENTS—*Continued*

Date	Mine or Quarry	Name of Proprietor	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
March 1	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Donat Barbeau	35	Laborer	Left eye injured	Some sand fell into his eye.
" 7	B. & A. Asbestos Co.	B. & A. Asbestos Co.	Télesphore Fortier	63	Carpenter	Thumb cut off	When planing a piece of wood.
" 8	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Calix Cloutier	28	Laborer	Contusion of instep and toe	Piece of rock rolled on his foot.
" 11	King's Mine	Asbestos Corporation of Canada Ltd.	Onésime Collet	58	Car loader	Shoulder injured	A bale of hay fell on him.
" 13	"	" "	A. Lapointe	26	Mill man	Cut right index finger	Finger caught between an eccentric and a pole.
" 17	Delson Jet. Plant	National Brick Co. of Laprairie Ltd.	Edward Kemp	39	Laborer	Contusion left side	Fell with load of brick.
" 18	Eustis Mine	Eustis Mining Co.	William Gardner	.....	"	Collar bone broken	Struck by a skip when being lowered from top.
" 19	Black Lake Chrome & Asbestos Co. Ltd.	Black Lake Chrome & Asbestos Co. Ltd.	Alaide Bélanger	15	Box dumper	Broken leg and crushed foot	A moving rock car passing over his left foot.
" 24	Bowie Shaft	Calumet Metals Co.	Peter Pépin	32	Miner	Crushed foot	Fell from top of a ladder, about 55 feet.
" 24	"	" "	Emmanuel Godin	30	"	Back and side hurt	Fell from top of a ladder, about 55 feet.
" 28	British Canadian Mines, Black Lake	Asbestos Corporation of Canada Ltd.	A. Courcil	28	Brakeman	Thumb crushed	While coupling up loaded cars.
April 1	" "	" "	A. Gasham	38	Pit laborer	Left leg broken	Rock weighing 100 lbs. rolled down.
" 3	B. & A. Asbestos Co.	B. & A. Asbestos Co.	Jos. Nadeau	56	Miner	Four fingers smashed	Right hand crushed under a car.
" 8	No. 9 Pit	Black Lake Chrome & Asbestos Co. Ltd.	Tondonki Manni	27	Laborer	Injured in head	Explosion when loading a hole for blasting.
" 8	"	" "	Hilaire Herbert	28	Drill helper	Leg bruised	Explosion when loading a hole for blasting.
" 8	"	" "	Jean Ouellet	43	Foreman	Injuries in head and eyes	Explosion when loading a hole for blasting.
" 8	"	" "	Edmond Trudel	21	Driller	Hole in left leg	Explosion when loading a hole for blasting.
" 9	B. & A. Asbestos Co.	B. & A. Asbestos Co.	Jos. Dion	30	Electrician	Right foot bruised	Right foot caught between cable and carriage wheel.

April	14	Carrière de Beauport	La Compagnie de Briques de Québec Ltée	Octave Viger	22	Driller	Forearm and back bruised	Explosion of boiler.
"	15	Delson Jct. Plant	National Brick Co. of Laprairie Ltd	Jos. Courcy, Jr.	20	Laborer	Cut on back of head	Struck by a wire rope.
"	15	Johnson's Co. Mine	Johnson's Co	John Gavin	49	"	Scalp wound	Stone fell from side of pit.
"	15	" "	"	Ovide Métivier	44	"	Bruised leg	Stone fell from side of pit.
"	15	" "	"	Thomas Paré	21	"	Leg broken	Stone fell from side of pit.
"	18	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Auton Jurourk	23	"	Contused wound of instep and foot	Foot caught beneath a box.
"	20	Canada Cement Co.	Canada Cement Co	John Hall	54	Powder man	Hands cut	Explosion whilst loading holes with dynamite.
"	21	Bell Asbestos Mines	Bell Asbestos Mines	Napoléon Doyon	30	Laborer	Foot bruised	Stone jammed his foot.
"	22	Canada Cement Co.	Canada Cement Co	George Tomka	24	Belkman	Cut on crownof head	Struck by bucket of rock.
"	24	Johnson's Mine	Johnson's Co	Joseph Landry	40	"	Finger taken off	Finger caught between a chain and piece of rock.
"	24	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Louis Voyer	56	Laborer	Right side of lumbar muscles contused	Slipped down between car and stand.
"	25	King's Mines	Asbestos Corporation of Canada Ltd	Oliva Dussault	34	Superintendent	Finger badly crushed	Hand slipped through an opening of disintegrator.
"	28	Carrière de Granit à Roussillon	The Laurentian Granite Co. Ltd	Mathias Paquette	26	Laborer	Finger crushed	Struck by hammer.
"	30	Canada Cement Co.	Canada Cement Co	A. Livichi	50	Quarryman	Contusion	Was elevated about 6 feet and fell on rock.
May	3	National Brick Co. Delson Jct. Plant.	National Brick Co. of Laprairie Ltd	E. Lamagdelaine.	17	Laborer	Finger broken	Touched crown gear.
"	5	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Elzéar Derouin	51	"	Fracture of 9th rib	Struck by handle of car brake.
"	6	Rivière à Pierre Quarry	M. P. & J. T. Davis	Jos. Vallières	.....	"	Lost one eye	In blasting operations.
"	9	Carrières de Granit à Roussillon	The Laurentian Granite Co. Ltd	John Cummings	65	"	Leg bruised	Struck by hammer when drilling.
"	13	Jeffrey Mine	Asbestos & Asbestic Co Ltd.	William Allsop	21	"	Fracture of right femur	Piece of frozen earth falling on his leg.
"	19	"	" "	Eugène Plourde	22	"	Contused finger	Caught by piece of rock.
"	26	"	" "	Dimitro Radish	28	"	Fracture of right femur	Dirt fell on his leg.
"	29	Granite Quarry at Roussillon	The Laurentian Granite Co. Ltd	.....	.....	Carpenter	Hurt his left foot	Slipped and sprained his left ankle.
"	31	Bell Asbestos Mines	Bell Asbestos Mines	Art. Boisvert	52	Switchman	Right leg squeezed.	Struck by locomotive when crossing the track.

NON-FATAL ACCIDENTS—*Continued*

Date	Mine or Quarry	Name of Proprietor	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
June 6	King's Mines	Asbestos Corporation of Canada Ltd.	N. Coté	23	Drill helper	Finger crushed	Finger caught between drill and rock.
" 6	Rock	Canada Cement Co.	Toader Yames	34	Laborer	Right hand cut	Struck by piece of rock.
" 12	Bell Asbestos Mines	Bell Asbestos Mines	Jean Nadeau	16	Oiler	Bone out of joint	Fell from one floor to the other.
" 12	" "	" "	Chs. Lemay	46	Brakeman	Finger bruised	Cars got off the track.
" 14	King's Mines	Asbestos Corporation of Canada Ltd.	Jos. Roy Jr.	22	Miner	Finger amputated	Piece of rock fell on his finger.
" 16	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Robert Reed	22	Laborer	Contused back	Caught beneath an empty box.
" 18	King's Mine	Asbestos Corporation of Canada Ltd.	J. St. Laurent	39	Miner	Finger crushed	Finger struck by chain.
" 18	Laprairie Plant	National Brick Co. of Laprairie Ltd.	Edmond Lussier	30	Laborer	Scalp wound	Brick fell on his head.
" 18	King's Mines	Asbestos Corporation of Canada Ltd.	Jos. Lessard	24	Driller	Fingers crushed	Caught hand between drill chuck and rock.
" 20	Canada Cement Co.	Canada Cement Co.	Walter Johnston	25	Teamster	Struck on side	Struck by lever.
" 23	Jacobs Asbestos Mining Co. Ltd.	Jacobs Asbestos Mining Co. Ltd.	W. Plourde	41	Laborer	Cut on head	Fell in the pit about 40 feet.
" 24	King's Mines	Asbestos Corporation of Canada Ltd.	Adélard Dupuis	32	Hoistman	Piece of wire rope in right eye	Piece of wire rope flew back.
" 26	Jacobs Asbestos Mining Co. Ltd.	Jacobs Asbestos Mining Co. Ltd.	Alex. Poulin	39	Trackman	Rib broken	Fell seven feet high.
" 30	Bell Asbestos Mines	Bell Asbestos Mines	Jean Jobin	63	Pit laborer	Eye injured	Stone flew into his eye.
July 3	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Alcidose Bisson	33	Driller	Contused hips and back	Piece of rock rolled pinning him to ground.
" 9	British Canadian Mines, Black Lake	Asbestos Corporation of Canada Ltd.	H. Crasmick	29	Laborer	Eye injured	Piece of rock flew into the righ eye.
" 14	Laprairie Plant	National Brick Co. of Laprairie Ltd.	Firmus Roy	39	"	Finger of right hand crushed	Deck of dryer car slipped and caught his finger.
" 14	" "	" "	Henri Alain	35	"	Eye injured	Piece of broken wheel flew into his eye.

July	15	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	George Brindle	25	Brakeman	Right shoulder dislocated	Slipped and fell on rock.
"	19	King's Mines	Asbestos Corporation of Canada	Onésime Gagné	56	Miner	Sprained back	Fell into a hole.
"	22	British Canadian Mines, Black Lake	" "	Vasil Ivanovitch		Pit laborer	Compound fracture little finger	Finger caught between two large rocks.
"	23	Jacobs Asbestos Mining Co	Jacobs Asbestos Mining Co.	Achille Goudreau	24	"	Left leg bruised	When loading boxes.
Aug.	4	La Cie de Briques de l'Islet Ltée	La Cie de Briques de l'Islet Ltée	Ernest Chouinard	20	"	Fingers crushed	Hand caught between two pulleys.
"	4	Laprairie Plant	National Brick Co. of Laprairie Ltd	Guiseppe Paradisis		Laborer	Toes crushed	Wheel of car passed over his toes.
"	5	Rock Quarry	Canada Cement Co.	F. Kascrucawya	45	"	Feet swollen	Jumped eight feet.
"	5	Canada Cement Co.	" "	Georges Pilotte		"	Burnt and bruised about head, body and limbs	Premature explosion of dynamite.
"	5	" "	" "	R. Nazpvitch		"	" "	Premature explosion of dynamite
"	5	" "	" "	Masino Lionebusso		"	" "	Premature explosion of dynamite.
"	5	" "	" "	Francisco Rochetti		"	" "	
"	5	" "	" "	Toma Voysing		"	" "	Premature explosion of dynamite.
"	6	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Edmond Audard	33	Laborer	Scald on right foot	Steam burn on his foot.
"	7	"	" "	A. Zabriduck	40	"	Contusion and wrench of knee	Piece of earth fell on his leg.
"	7	The Deschambault Stone Co. Ltd.	The Deschambault Stone Co. Ltd	Alex. Marquis	34	Foreman	Crushed foot	Stone fell on his foot.
"	9	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Charles Desautel	42	Laborer	Contused right thigh	Leg caught between two cars.
"	11	Rock Quarry	Canada Cement Co.	Dunnko Eveoliolink	25	"	Head and finger crushed	Rock fell and crushed his hand and finger.
"	11	Granite Quarries	The Laurentian Granite Co, Ltd	Paul Léveillé	60	"	Cut on left thumb	Struck by shovel.
"	12	King's Mines	Asbestos Corporation of Canada	Arthur Mercier	20	Driller	Wound on scalp	Caught by a wire cable throwing him on to the rocks.
"	13	Rock Quarry	Canada Cement Co.	Geo. Karfuik	24	Laborer	Toe bruised	A rock rolled on his foot.
"	14	Canada Cement Co.	" "	L. Gravelle	26	Quarryman	Left wrist cut	Cracked stone split and cut his wrist.
"	14	" "	" "	E. Legault	28	"	Right arm and knee slightly cut	Struck by flying stones when blasting.

NON-FATAL ACCIDENTS—*Continued*

Date	Mine or Quarry	Name of Proprietor	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
August 14	King's Mines	Asbestos Corporation of Canada	Edouard Morin	26	Miner	Head, shoulder and stomach bruised	Pit box slacked away too quickly.
" 15	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Thomas Gifford	55	Laborer	Right forearm contused	Slipped on a piece of rock.
" 16	National Brick Co. of Laprairie Ltd.	National Brick Co. of Laprairie Ltd	John Spears		"	Shoulder dislocated. and collar bone broken	Fell under locomotive whilst in motion.
" 23	Rock Quarry	Canada Cement Co	Pit Rubitt	40	"	Big toe bruised	Struck by a sledge.
" 26	King's Mines	Asbestos Corporation of Canada	Geo. Gagné	46	Hoister	Chest crushed	Struck by a derrick.
" 26	"	" "	Jos. Fortin	32	Miner	Right thigh injured.	Struck by a derrick.
" 27	Rock Quarry	Canada Cement Co	A. Floiczeruk	24	Laborer	Finger cut	Whilst rolling a large rock.
" 27	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Lucien Morrel	25	Carpenter	Fracture of right shoulder	A plank fell on his shoulder.
" 29	Bell Asbestos Mines	Bell Asbestos Mines	Joe Langlois	62	Laborer	Left leg bruised	Leg jammed between a crowbar and hoisting box.
" 30	Jeffrey Mine	Asbestos & Asbestic Co. Ltd	Edmond Tellier	23	"	Eyes, face and head badly injured	Explosion of dynamite.
Sept. 1	Rock Quarry	Canada Cement Co	Eugène Lauzon	28	Quarryman	Shoulder bruised	Struck by rock-bucket.
" 3	"	" "	T. Resnak	45	"	Left arm and both legs bruised	Struck by a rolling stone.
" 3	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Joseph Barbacone.	21	Laborer	Contused wounds of left arm	Piece of rock rolled on his arm.
" 6	Laprairie Plant	National Brick Co, of Laprairie	Gédéon Gervais	43	"	Cut on back of head	Fall between two cars.
" 9	Granite Quarry	The Laurentian Granite Co. Ltd	Léonard Therrien.	18	"	Finger crushed	Struck by stone.
" 10	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Octave Cloutier	27	"	Contusion wound, index finger	Finger caught between the links of a chain.
" 12	British Canadian Mines	Asbestos Corporation of Canada Ltd	Donat Vaillancourt	30	Oiler	Bruised all over body	Was caught at bottom in gear.
" 12	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Louis Perrault	42	Laborer	Contusion of left side	Piece of rock rolled and threw him down.
" 15	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Edward Blanchette	25	Laborer	Contusion of right side	Struck by a bag.

Sept.	16	Carrière Calcaire	The Deschambault Stone Co Ltd	Eugène Marois	38	Laborer	Right foot bruised	Shed fell on foot.
"	19	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Zoemagui Ayomkibur	25	"	Contusion of right hip	Struck by a piece of rock.
"	20	King's Mine	Asbestos Corporation of Canada	Omer Gosselin	32	Blacksmith	Finger crushed	Struck by hammer.
"	20	Jeffrey Mines	Asbestos & AsbesticCo. Ltd.	John Arsenault	35	Laborer	Contusion of two toes	Rock fell on his toes.
"	23	"	" "	Miron Bojczuk	40	"	Contusion of left wrist	Fell from height of ten feet.
"	24	King's Mines	Asbestos Corporation of Canada Ltd.	Albert Vermette	17	Oiler and sweeper.	Right arm torn from body	Caught by a set screw on a shaft.
"	25	Laprairie Plant	National Brick Co. of Laprairie Ltd.	Charles Paradis	61	Laborer	Scalp wound	Head scraped.
"	26	Jacobs Asbestos Mining Co.	Jacobs Asbestos Mining Co.	John Dombroski	39	Mill laborer	Finger cut off	Rope cut off his finger.
"	26	Granite Quarry	The Laurentian Granite Co. Ltd.	Henry Mayo	29	Quarryman	Finger bruised	Finger caught between stone and side of car.
"	30	Rock Quarry	Canada Cement Co.	O. Charette	33	"	Toe bruised	Piece of stone rolled on foot.
Oct.	2	Jeffrey Mine	Asbestos & Asbestic Co.	Alphonse Dureau	42	Laborer	Contusion of fingers	Piece of rock rolled on his fingers.
"	4	"	" "	Israel Derocher	52	"	Contusion of right hand	Struck by a piece of rock.
"	5	Rock Quarry	Canada Cement Co.	A. Laroque	31	Quarryman	Toe jammed	When breaking stone.
"	6	Granite Quarry	The Laurentian Granite Co. Ltd.	Ed. Girard	24	Quarryman	Hand cut	While handling a stone with crowbar.
"	6	Rock Quarry	Canada Cement Co.	E. Cyr	31	"	"	A piece of stone flew up and cut his hand.
"	7	Delson Jct. Plant	National Brick Co. of Laprairie Ltd.	E. W. Martin	35	Laborer	Back bruised	Slipped when firing boiler.
"	8	Rock Quarry	Canada Cement Co.	B. Noibruik	26	"	Stomach crushed	A stone rolled on top of him.
"	8	"	" "	E. Lauzon	29	"	Hand cut	While lifting a piece of rock.
"	8	British Canadian Mines	Asbestos Corporation of Canada Ltd.	Wm. Bellavance (alias Gagné)	45	Foreman	Ribs broken and arm crushed	Struck by a pole when raising a piece of track.
"	10	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Hormisdas Charland	19	Laborer	Contused fingers	Fingers caught between rock and edge of box.
"	11	King's Mines	Asbestos Corporation of Canada Ltd.	M. Cavawchenko	18	Miner	Leg and arm broken	Box loaded with rock struck leg and arm.
"	14	Beauport	La Cie de Briques de Québec Ltée	Z. Chamberland	42	Laborer	Serious wounds	Crushed between a car and post.

NON-FATAL ACCIDENTS—*Continued*

Date	Mine or Quarry	Name of Proprietor	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
Oct, 16	Rock Quarry	Canada Cement Co.	E. Flenzneak	27	Quarryman	Mouth bruised	A piece of stone flew up into his mouth.
" 17	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Damase Dionne		Laborer	Contused fingers	Fingers caught between rock and edge of box.
" 22	Rock Quarry	Canada Cement Co.	L. Froment	45	"	Left foot crushed	A piece of rock fell on his foot.
" 28	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Jos. Filteau		"	Contused fingers	Fingers caught between two pieces of rock.
" 29	King's Mines	Asbestos Corporation of Canada Ltd.	Nap. Laroche	25	Dumpman	Little finger right hand broken	Finger struck with a hammer.
" 31	Rock Quarry	Canada Cement Co.	O. Raymond	35	Laborer	Thumb crushed	Rock slipped and fell on his thumb
Nov. 1	Rock Quarry	Canada Cement Co.	N. Roosevan	45	Laborer	Finger crushed	Stone fell on his finger.
" 4	British Canadian Mines, Black Lake	Asbestos Corporation of Canada Ltd.	E. Grégoire	17	Dumpman	"	In coupling loaded cars.
" 5	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Hervie Labarrie	20	Laborer	Fracture of fibula	Large rock rolled on his leg.
" 6	LaCie de Briques de l'Islet Ltée	La Cie de Briques de l'Islet Ltée	Alfred Chouinard	39	"	Finger crushed	When moving a piece of wood.
" 7	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Nicola Postepski	26	"	Contused wound right hand	Large rock rolled on his hand.
" 10	Rock Quarry	Canada Cement Co.	G. Fluslak	20	"	Toe crushed	Rock fell on his foot.
" 11	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Metro Mothaliuk		"	Fracture bones left hand	Piece of rock rolled on his hand
" 12	Beaver Mine	Asbestos Corporation of Canada Ltd.	A. Matteau	20	Miner	Right hand burnt	While lighting fuses.
" 12	King's Mines	" "	Laureat Turcotte	16	"	Finger bruised	Stone fell on his hand.
" 13	Carrière de pierre calcaire	The Deschambault Stone Co. Ltd.	Alfred Gagné	23	Laborer	Hand bruised	In loading a stone.
" 13	King's Mines	Asbestos Corporationof Canada Ltd.	O. Sévigny	28	Driller's helper	Finger bruised	While moving the drill.
" 18	Johnson's Co.	Johnson's Co.	Adélard Lafrance	24	Hoistman	Finger taken off	Tightening a nut on driving ro l
" 18	King's Mines	Asbestos Corporationof Canada Ltd.	Frs. St. Laurent	62	Millman	Right hand crushed	Stone fell on his hand.
" 19	Carrière de pierre calcaire	The Deschambault Stone Co. Ltd.	Jos. Chalifour	35	Laborer	Finger crushed	While loading a stone.
" 19	Rock Quarry	Canada Cement Co.	Josephat Cousineau	28	Quarryman	Left foot cut	Piece of stone rolled on foot.

Nov.	21	King's Mines	Asbestos Corporation of Canada Ltd.	Cyrille Doyon	19	Laborer	Wrist broken	Caught between two boxes.
"	24	Granite Quarry	James Brodie	Walter Coburn	30	Quarryman	Wound in calf of leg	Caught by dumped car.
"	24	Beaver Mine	Asbestos Corporation of Canada Ltd.	P. Fredette	23	Dumpman	Left hand smashed.	While placing a box on to a car.
"	26	Rock Quarry	Canada Cement Co.	J. Litock	26	Laborer	Finger crushed	Stone rolled on finger.
Dec.	1	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Baptiste Beaurivage	37	Driller	Foot ankle crushed.	A piece of rock struck him.
"	1	British Canadian Mines Black Lake,	Asbestos Corporation of Canada Ltd.	V. Saramonocoski,		Pit laborer	Big toe broken	Large stone rolled on his foot.
"	3	King's Mines	" "	Aimé Paquet	30	Miner	Knee bruised	Stone rolled and struck his knee.
"	3	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Israel Derocher	52	Laborer	Fracture of skull	Struck by stone while blasting.
"	4	Argenteuil Granite Co. Quarry	Argenteuil Granite Co., Ltd.	John McDonald		"	Bruises and cuts to face	Shot of blasting powder.
"	6	King's Mines	Asbestos Corporation of Canada Ltd.	Wilfrid Huot	20	Brakeman	Thumb bruised	Coupling cars.
"	9	"	" "	Théodore Landry	36	Miner	Right foot sprained.	Jumping from platform on frozen earth.
"	9	British Canadian Mines, Black Lake	" "	G. Lafrance	16	Pit laborer	Left foot bruised	Struck by a rock.
"	9	The Quebec Graphite Co.	The Quebec Graphite Co.	N. Leclaire	25	Laborer	Cuts and bruises	Hit by pieces of falling ore.
"	11	Jeffrey Mine	Asbestos & Asbestic Co. Ltd.	Georges Landry	34	"	Contusion of finger	Struck by falling drill.
"	18	"	" "	Alfred Picard	53	"	Contused wound to toes	Struck by car.
"	18	King's Mines	Asbestos Corporation of Canada Ltd.	J. N. Samson	45	Miner	Cut on head	Struck by stone.
"	22	Beaver Mine	" "	J. Lessard	33	Carpenter	Finger smashed	Finger caught in machine.

MINING OPERATIONS.

ASBESTOS.

During the calendar year 1913, returns of shipments of asbestos were received from nine producers, and both in quantity and value these shipments show a very appreciable increase on the previous year's figures.

In the twelve months ending December 31st, 1913, 136,609 tons of asbestos fibre were shipped from the producing centers, which are Thetford Mines, Black Lake, Danville and East Broughton. From East Broughton, however, the shipments were small and made from stock on hand, as none of the mines of that district were operated during the year.

The value of the asbestos shipped reached $3,830,504, the highest yet recorded. This was somewhat in excess of the output during the year, the balance being shipped from stock on hand, which had accumulated during previous years. These figures are exclusive of the value of asbestic, which is a by-product of the asbestos mills. The shipments of asbestic, or asbestic sand, amounted to 28,473 tons, valued at $20,346, or an average of 71c a ton.

In the past 11 years, the asbestos industry has had a marked growth and development, as the following table shows, giving the quantities and the values of the shipments annually since 1903.

Year	Tons	Value
1903	29,261	$ 916,970
1904	35,479	1,186,970
1905	48,960	1,476,450
1906	61,675	2,143,653
1907	61,985	2,455,919
1908	65,157	2,551,596
1909	63,965	2,296,584
1910	80,605	2,667,829
1911	102,224	3,026,306
1912	111,175	3,059,084
1913	136,609	3,830,504

For the purpose of comparisons, the details of the shipments of asbestos for the past four years are given in the following tables:

PRODUCTION OF ASBESTOS FOR 1913.

	Shipments			Stock on Hand	
	Tons	Value	Average Value per Ton	Tons	Value
Crude No. 1	2,140	$588,310	$275.00	880	$247,787
Crude No. 2	2,870	384,559	134.00	1,522	178,767
Mill Stock No. 1	14,056	829,440	59.00	4,545	278,374
Mill Stock No. 2	29,525	817,963	27.75	3,862	121,545
Mill Stock No. 3	88,018	1,210,232	13.75	9,932	112,825
Totals	136,609	$3,830,504	28.04	20,741	$939,298

Quantity of rock mined during year 1913, 2,527,410 tons.

PRODUCTION OF ASBESTOS FOR 1912.

	Shipments			Stock on Hand	
	Tons	Value	Average Value per Ton	Tons	Value
Crude No. 1	1,941	$510,785	263.16	867	$221,215
Crude No. 2	3,766	379,445	100.76	2,867	310,596
Mill Stock No. 1	3,682	237,203	64.42	2,370	137,106
Mill Stock No. 2	32,689	1,018,960	31.17	8,234	301,774
Mill Stock No. 3	69,097	912,691	13.21	6,838	131,515
Totals	111,175	$3,059,084	$27.52	24,176	$1,102,206

Quantity of rock mined during year 1912, 1,870,608 tons.

PRODUCTION OF ASBESTOS FOR 1911.

	Shipments			Stock on Hand	
	Tons	Value	Average Value per Ton	Tons	Value
Crude No. 1	1,400	$388,224	$277.30	1,358	$360,304
Crude No. 2	3,382	382,980	113.68	3,368	431,548
Mill Stock No. 1	6,340	415,559	65.54	3,794	207,403
Mill Stock No. 2	35,991	1,091,784	30.33	12,272	379,523
Mill Stock No. 3	55,111	747,759	13.57	12,959	204,298
Totals	102,224	$3,026,306	29.60	33,751	$1,583,076

Quantity of rock mined during year 1911, 1,759,064 tons.

PRODUCTION OF ASBESTOS FOR 1910.

	Shipments			Stock on Hand on Dec. 31st, 1910	
	Tons	Value	Average Value per Ton	Tons	Value
Crude No. 1	1,817	$471,649	$259.57	1,763	$447,227
Crude No. 2	1,612	196,382	121.82	3,181	440,884
Mill Stock No. 1	10,313	627,635	60.88	4,938	313,053
Mill Stock No. 2	44,793	1,141,374	25.48	24,417	612,065
Mill Stock No. 3	22,070	230,789	10.46	6,920	99,694
Totals	80,605	$2,667,829	33.10	41,159	$1,921,923

Quantity of rock mined during year 1910, 2,035,705 tons.

The classification adopted by the Mines Branch is an arbitrary one. In Crude No. 1, we put all hand-cobbed asbestos valued at $200 a ton and over; Crude No. 2 is hand-cobbed asbestos valued at less than $200. Mill Stock Nos. 1, 2 and 3, are respectively $45 and over; between $45 and $20; and under $20 a ton.

Each producer has his own method of grading and his own special mark or designation for each grade. In Mill Stock No. 1, we have grouped grades which have been given in the returns under the following designations: "X," "Special," "C," "1 A," "2 A," "No. 1," "No. 2," "AAA," "SB," "16a," "21," "23," "X," "U."

In Mill Stock, No. 2, valued between $20 and $45, we notice, "LN," "OK," "JS," "D," "RM," "E," "No. 2," "No. 3," "No. 4," "2X," "SA & C," "SB & SC," "BF," "L," "M," "A," "XX."

In Mill Stock No. 3 are grouped the following designations: "XX," "C," "D," "F," "3B," "C," "No. 3," "No. 5," "No. 2," "No. 3X," "SD," "E," "F," "XXX," "Z," "C," "F," "KP," "S."

In our report for the year 1910, we gave a similar list, and in comparing these, it will be seen that very few of the designations given in 1910 are retained in 1913. Except to the companies which actually produce the grades referred to, these designations convey no meaning, and must necessarily puzzle the buyer. Therefore, under the present system, the sales of asbestos can only be effected by samples. If these various grades could be standardized, and a uniform classification adopted, a great deal of work and expense in selling organizations of the various companies would be saved, and moreover, it would help towards putting the asbestos market on a rational and systematic basis.

There has been a marked improvement in the asbestos market during 1913, and although the conditions at the close of the year were not yet ideal, they were more satisfactory than they have been for several years. The working margin of profits in the asbestos industry is narrow. Taking last year's figures, and taking into account the shipments from stock on hand, we see that the actual value of the asbestos extracted from the rock during the year reached a value of $3,665,197. This is allowing the same prices for the stock on hand as for the shipments sold. This value of asbestos was extracted from 2,527,410 tons of rock. At this rate, the average yield of each ton of rock was only $1.45. In 1912, this figure was $1.38, and in 1911, it was $1.53.

It is true that about 20% of the rock goes direct to the dumps or refuse heaps, and is not treated in the mills, but nevertheless all of

it has to be quarried and hoisted to the surface from depths reaching over 200 feet.

None of the mines of the East-Broughton district were re-opened in 1913, and at Robertson, only one mine was in operation. The fibre of the East-Broughton rock is short and its market value is low, but, on the other hand, the proportion of fibre extracted from the rock is high.

Active operations were therefore confined to Thetford, Black Lake, Asbestos, and to one mine in Robertson. That is, out of twenty-one asbestos plants, twelve were operated.

The greater part of the Canadian asbestos is exported to the United States, which takes over 60% of our production. Other countries to which Canadian asbestos is exported, in the order of their importance, are Germany, Great Britain and France.

Eight companies were in active operation during the year 1913, at Thetford Mines, Black Lake, Asbestos and Robertson. These companies were working twelve mines.

The Asbestos and Asbestic company have a new mill in course of construction and are introducing radical changes in their methods of working. They intend to discard the cable derrick method of hoisting, which, it is claimed, is expensive both in operation and in maintenance. This will be replaced by an incline and mine-cars from the bottom of the quarry to the mill. Moreover, a huge jaw-crusher will be installed in the pit, large enough to do away with block-holing. All the loading of tramcars will be done by steam shovels.

The Asbestos Corporation of Canada Limited operated three mines, the King's and the Beaver at Thetford, and the British-Canadian at Black Lake. The Standard and the Dominion, two other mines belonging to the corporation, remained idle during the year.

The Black Lake Asbestos and Chrome Company operated the two mines, the Union and the Southwark, situated on lots Nos. 27 and 28, range B, township of Coleraine. The rock of both these mines is sent to a large mill, which has a capacity of 1,000 tons per ten hours.

The Bell Asbestos Mines, operating the Bell mines, lot 27, range V, of Thetford, worked very steadily, both in the underground

workings and in the open cast pit. This company has a large reserve of asbestos rock, proved by about 20,000 lineal feet of levels and tunnels. The Bell Asbestos have almost altogether discarded the cable derrick hoisting system and replaced it by the incline system.

The B. & A. Asbestos Company's mine was the only mine operated in the Robertson district, on lot 9, range V, of Thetford township.

The Jacobs Asbestos Company, on lot 28, range VI, Thetford township, produced steadily during the year. The mill has a capacity of 600 tons of rock per ten-hour shift.

The Martin-Bennett Asbestos Mines, Ltd., operating the Ward-Ross mine, lot 27, range V, of Thetford, report a year of successful operation. The new mill has now a daily capacity of 1,200 tons of rock. For power, they use steam altogether, the power plant being built for 1,600 H.P., for both mining and milling.

The Johnson's Company worked their two plants steadily, lot 27, range VI, Thetford, and lot 27, range B, Coleraine, near Black Lake.

ASBESTOS DEPOSITS OF VARIOUS COUNTRIES.

Canada.—The most important asbestos deposits in the world are those of the serpentine belt of the Province of Quebec. They are situated in the townships of Thetford, Broughton, Coleraine and Shipton, in the counties of Megantic, Beauce and Richmond, to the south of the river St. Lawrence. Asbestos is produced in five distinct centres, where there are well equipped mines and mills, the output of which constitutes about 80% of the world's supply of asbestos. Four of these centres, Black Lake, Thetford, Robertson and East Broughton, are practically in a straight line, twenty-five miles long, on the outcrop of an elongated batholith of ultra-basic rocks, peridotite, serpentine, pyroxenites, diabases, gabbros. The fifth centre, east of Danville, is on a separate and distinct intrusion of similar rocks, situated some forty miles in a straight line to the south-west of Black Lake. From these five centres is extracted the whole production of Canadian asbestos, which, in 1913, amounted to 136,609 tons, valued at $3,830,504. A short geological description of these deposits is given further on in this report.

Asbestos also occurs in the province in connection with bands of crystalline limestones of Laurentian age, which contain patches of serpentine. This serpentine is found in scattered masses in the limestone, and its colour is usually lighter than the serpentine derived from the peridotites. It is more of a waxy yellow than green. Some of these deposits have been worked for the asbestos, but owing to the disseminated and irregular character of the occurrences, they have all been abandoned. One of these deposits, in the township of Templeton, lot 11, range VII, has been described as follows, by F. Cirkel, in his Report on Asbestos (Dept. of Mines, Ottawa): "This deposit, which outcropped on the surface in elliptical form, with the larger diameter 50 feet, and serpentine walls of a width of 2′ 6″ to 3′, and containing excellent fibre of from ¼″ to 1½″ in length, continued to a depth of 60 feet in great regularity. At this depth, a drift was run along one of the walls, and it was found that the character and horizontal extension of the deposit was precisely similar to those exposed on the surface. In sinking, however, the asbestos veins gradually disappeared, the serpentine being broken up into smaller pockets and bunches, containing only a few stringers of the mineral. It was often observed that asbestos of 1″ and 2″ in length on the surface, disappeared when the vein was followed in depth."

This description is typical of deposits in the Laurentian rocks, and analogous occurrences are known on lot 16, range V, of Portland west; lot 14, range VII, Templeton; lot 2, range VIII, Templeton; lot 16, range V, Templeton; lot 20, range IX, Wentworth; lot 42, range I, Denholm; lot 4, range II, Grenville (augment); lot 13, range VII, Wright.

Occurrences of asbestos in olivine rocks, in the region of the headwaters of the Harricanaw river, in North-western Quebec, were described in the Report on Mining Operations in the Province of Quebec during the year 1912. Although the occurrences observed so far are not of workable size, yet the conditions and the rock associations indicate the possibility of discovering deposits of economic value.

Russia.—The Russian deposits of asbestos are situated in the Ural Mountains, to the north-west of Ekaterinburg. The asbestos-bearing rock occurs in ellipsoidal deposits in a belt of serpentine

rock. Russia is the second largest producer of asbestos in the world, ranking immediately after the Province of Quebec. Nevertheless, the Russian production in 1912 was only about 18,000 short tons, whereas the Canadian mines shipped 111,175 tons in 1912 and 136,609 tons in 1913.

It is very difficult to get reliable figures of Russian asbestos production. The latest official figures, published by the "Scientific Mining Committee," St. Petersburg, cover the years 1908 and 1909. For subsequent years, the data are obtained from unofficial sources, and are subject to correction.

PRODUCTION OF RUSSIAN ASBESTOS.

Year	Metric Tons	Value
1908	11,911	£175,452
1909	15,044	234,948
1910	10,847	.....
1911	15,182	.....
1912	16,000	.....
1913	9,060	.....

The average value of the Russian asbestos, derived from the above figures, appears to be between $70 and $80 a ton. This would indicate that only the higher grades (long fibre) of asbestos are shipped from the Russian mines, for, as a rule, the Ural asbestos is more brittle and less silky than the Canadian fibre, and commands a lower price for the same length of fibre. The Canadian asbestos is better suited for textile purposes.

United States.—The United States come third in importance as producers of asbestos, but the production is irregular and varies considerably from year to year. Figures for 1913 are not yet available, but the production for the previous five years, as given by the "Mineral Resources of the U. S.," has been as follows:—

Year	Tons	Value	Average price per ton
1908	936	$ 19,624	$ 20.97
1909	3,085	62,603	20.29
1910	3,693	68,357	18.51
1911	7,604	119,935	15.77
1912	4,403	87,959	19.98

Two States contributed to the production of chrysotile asbestos—Vermont and Wyoming. In Georgia, at Sall mountain, deposits of the amphibole variety are worked, yielding a low-grade brittle fibre. By far the greater part of the United States production comes from Vermont, where the deposits are in the extension of the serpentine belt, which, to the north-east, gives rise to the asbestos deposits of the Province of Quebec, at Thetford, Black Lake and Danville.

In Wyoming, the main occurrences are in the Casper region. Referring to these occurrences in the "Mineral Resources of the United States, 1912," J. S. Diller makes the following statement: "In the Casper region of Wyoming, while the officers of several companies were being prosecuted for their methods of promotion, other companies have extended their prospects and have produced a small quantity of asbestos that has been taken to Chicago for manufacture into flooring. These companies report a small production and manufacture in Denver and Chicago, but the developments are very meagre. Other prospects have been reported from the Wind river mountains, north-west of Lander, that show good fibre, as much as three-fourths of an inch in length."

Small production is also reported from the following countries, according to "Colonial and Foreign Statistics," Mines and Quarries, Home Office, London.

	Metric Tons	Value
Cape Colony (1911)	1,137	£20,765
Cyprus (1911)	725	5,126
Natal	12	74
Rhodesia (1911)	418	6,396
Transvaal (1910)	70	2,595

COPPER AND SULPHUR ORE.

The shipments of copper-bearing ore from Quebec mines reached 87,550 tons during the year 1913. The total value of this ore, at the mines, was $812,899. This is an increase of 25,443 tons as compared with the previous year, or a proportional increase of 41% in quantity.

The great bulk of these shipments was of the high sulphur, low copper ores of the Sherbrooke district and of Weedon. Some shipments of copper ore were also made from the Ives mine, at Eastman.

The ores shipped from the mines of the Province of Quebec had a copper contents of 5,044,151 lbs. The pyrite ore contains an average of 42% sulphur.

Throughout the year, the copper market was satisfactory. The average price of the metal (electrolytic) for the year on the New York market was 15.27c. per lb., and the monthly average varied from 14.19c. in July to 16.488c. in January.

Practically the whole of the production of the Province of Quebec goes to sulphuric acid plants in the United States and Canada, where the ore is treated for the manufacture of acid, and the resulting cinders, containing the copper, are sent to smelters.

As already stated, the copper-bearing ores, which are at present being worked in the Province of Quebec, are high in sulphur and low in copper. It is therefore essential that their sulphur contents be utilized before they are submitted to smelter treatment for the recovery of the copper, as the sulphur represents a considerable proportion of the value of the ore.

The Eustis Mining Company, working the Eustis mine at Eustis, 7 miles south of Sherbrooke, report a very successful year. This deposit has been worked for more than thirty-five years, and the main slope is now down 3,500 feet, on an average dip of 38°.

During the year, an Elmore oil concentrator has been installed to relieve the congestion of the water concentrating mill. (See Reports for 1911 and 1912).

The shipments of the East Canada Smelting Co., operating the Weedon mine, at Weedon, increased considerably during the year. Nearly all the ore from this mine goes to acid plants in the United States.

This company has replaced its steam power plant by electrical power from the St. Francis Hydraulic Company. The power drives a compound air compressor, capacity 1,600 cubic feet, of free air per minute, which is used for drilling, pumping and hoisting.

Development work is kept well ahead of mining, and during this year 1,600 lineal feet of new work was done, giving a depth of 450 feet and a length of 600 feet along the strike.

Small shipments are reported from the Ives mine at Eastman, where the ore is a straight copper ore, containing ten to fifteen per cent. of the metal.

Prospecting work was done on several deposits, notably on lot 19, range II, south Garthby, where a shaft was sunk and stripping done on a quartz copper bearing vein; on lots 6, 7, 8, range VI of Stratford, on a promising lens of almost pure pyrite, unfortunately low in copper; on the Suffield mine, south of Sherbrooke; on a copper prospect near Orford Lake, and various other places.

USES AND MARKET OF PYRITE.

To give an idea of the importance of the demand for pyrite, it may be stated that the imports of this substance into the United States approximate 1,000,000 tons a year, and that the production of that country, including the low grade sulphides of Tennessee, amount to over 600,000 tons annually.*

The New York market price of the imported Spanish pyrite, which, as a rule, contains over 46% sulphur (theoretical composition of pyrite, sulphur 53.4; iron 46.6), is generally steady at 13c. per unit of gross ton. That is $5.98 per ton of pyrite of 46% sulphur contents. The domestic pyrite, as a rule, falls considerably below this contents in sulphur, and is not so desirable for acid making and other purposes. It varies between 35 and 46% and the prices are between 8 and 10c. per unit, averaging 9¼ according to the *Mineral Industry*. This would be $3.70 for 40% ore. Freight to the point of utilization would have to be deducted from these figures.

The main use of the pyrite is in the manufacture of sulphuric acid. This acid finds a wide application in the manufacture of fertilizers (superphosphates); in the manufacture of explosives; in the refining of crude petroleum, and in the soda industry. The artificial fertilizers industry and the soda industry consume between 80 and 90% of the sulphuric acid manufactured in the United States.

*See Mineral Resources, U.S., for 1912.

Another use of pyrite, which is likely to grow considerably in importance, is as a source of sulphur dioxide gas in the manufacture of sulphite pulp. Sulphite or chemical wood pulp is prepared by boiling the wood, cut in thin slices across the grain, in a chemical solution, bisulphite of lime in water, which removes all the resinous and gummy substances of the wood and leaves cellulose fibre in the state required for the manufacture of paper.

In the preparation of the sulphite liquor, either pure sulphur or pyrite may be used. The European pulp mills almost universally employ pyrite. In the United States and Canada, the great majority use the pure sulphur.*

Sulphur is much easier to handle than pyrite, which requires costly plants, specially constructed furnaces, and closer technical supervision. In fact the preparation of the sulphite liquor is at present undergoing the same evolution that the manufacture of sulphuric acid did in the middle of the last century. Until 1859, sulphuric acid was manufactured exclusively from native sulphur. In that year, pyrite began to be substituted for sulphur, and soon after, it was almost universally used.

Even now, in the present state of the process, most sulphite pulp mills would find a very notable economy in using pyrite instead of sulphur. In fact, only the mills most favorably situated on the sea board to receive the pure sulphur by water would have any advantage in using the latter.

In an article published in the *Pulp and Paper Magazine* (May, 1914) Mr. G. B. Steffanson states that, "If the pyrites can be delivered at the mill, containing 45% of sulphur, *at a price per unit of sulphur in the pyrites amounting to about 60% of the price of pure sulphur, it is generally good economy to use pyrites.*"

According to this statement, taking the price of sulphur at $23 a gross ton, at the mill, it would be good economy to use 45% pyrite at $6.21 per ton.

Even more favorable figures than these are given by Dr. A. W. G. Wilson*, who states that sulphur at $22.50 a ton could be replaced without disadvantage by 45% pyrite at $8.75 a long ton,

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*See Report, "Pyrites in Canada," by Dr. A. W. G. Wilson, Department of Mines, Ottawa.

and by 35% pyrite at $6.64. These last figures take into account the differences in the cost of the respective plants, depreciation, and difference in labor costs.

PRELIMINARY REPORT ON SOME COPPER DEPOSITS OF THE EASTERN TOWNSHIPS.

J. A. Bancroft.

During the past summer, a month was devoted to a study of the more important problems associated with the industry of copper mining in the Eastern townships. This work will be pushed more vigorously during the field season of 1914, and a final report then will be prepared in which an outline will be given of the geological relations of each of the more important mines and prospects. This study should contribute much information concerning the economic possibilities of the mines now working, and should aid in the guidance of those prospecting in this portion of the province.

Brief preliminary visits were paid to the Eustis mine at Eustis, a few miles south of Sherbrooke, the old Ives and the Huntington mines near Eastman, and a prospect a few miles from Garthby where considerable work has recently been done. A more critical examination was made of the geological conditions attending the occurrence of the large cupriferous pyrite body of the McDonald mine near Weedon, about 35 miles north of Sherbrooke, and the pyrite deposit at Stratford, about five miles to the north-east of the McDonald mine. More than forty prospects in the townships of Weedon and Stratford were examined. Although a systematic discussion of the geology and more detailed descriptions of the McDonald and the Stratford deposits will be reserved for the final report, a brief outline of their more striking features may be of immediate interest.

Geologically the area within which these ore bodies are situated was almost a complete surprise. The only geological map that exists of the area was published in 1886 on a scale of four miles to the inch by the Geological Survey of Canada. Upon this map, schistose, pre-Cambrian rocks and Ordovician sediments are re-

presented as occupying that portion of the area where the corners of Weedon, Lingwick, Stratford, and Winslow townships meet, whereas, in reality, there is here a body of granite which occupies at least 15 or 16 square miles, characterized by prominent hills, that, locally, are referred to as "The Block." A considerable portion of the area represented as being underlain by pre-Cambrian schistose rocks, was found to be occupied by Palaeozoic sedimentary rocks including limestones, within which fossils were found that determine them to be of Upper Silurian age. These limestones could not be distinguished from those which appear as Cambrian on the map; from structural considerations as well, they seem to be one and the same series of rocks. Large irregular dyke-like intrusions of the diabase pyroxenite group of rocks are intrusive into these sedimentary rocks, and at their contacts have marmorized the limestones to a very considerable degree. In one or two localities (as on lot 20a, range III), these basic intrusives, now very much altered and in part schistose, are traversed by a few small veinlets of poor asbestos. It seems reasonable to suggest that these rocks were injected at the same time as the larger bodies of quite closely related petrographical character which in other portions of the Eastern townships have produced large quantities of commercial asbestos. Apparently, the intrusive body of granite already referred to, together with its associated dykes, represents the youngest rocks within the area, having invaded all other rock-types, probably during the period of diastrophism which more or less metamorphosed the latest of the Palaeozoic rocks and the basic intrusives that penetrate them.

Although Weedon is now a well developed mine with an ore-body of large proportions, while the pyrite deposit at Stratford is only a prospect, in a discussion of their origin it is advantageous to make a comparison of their geological relations, and thus render more emphatic the similarities in their mode of occurrence. Both of these deposits are irregularly lenticular in shape, and occur within schistose volcanic rocks, striking and dipping in the same direction as the schists which enclose them. In each case the schists strike north-east and dip to the south-east. The schists roll somewhat, so

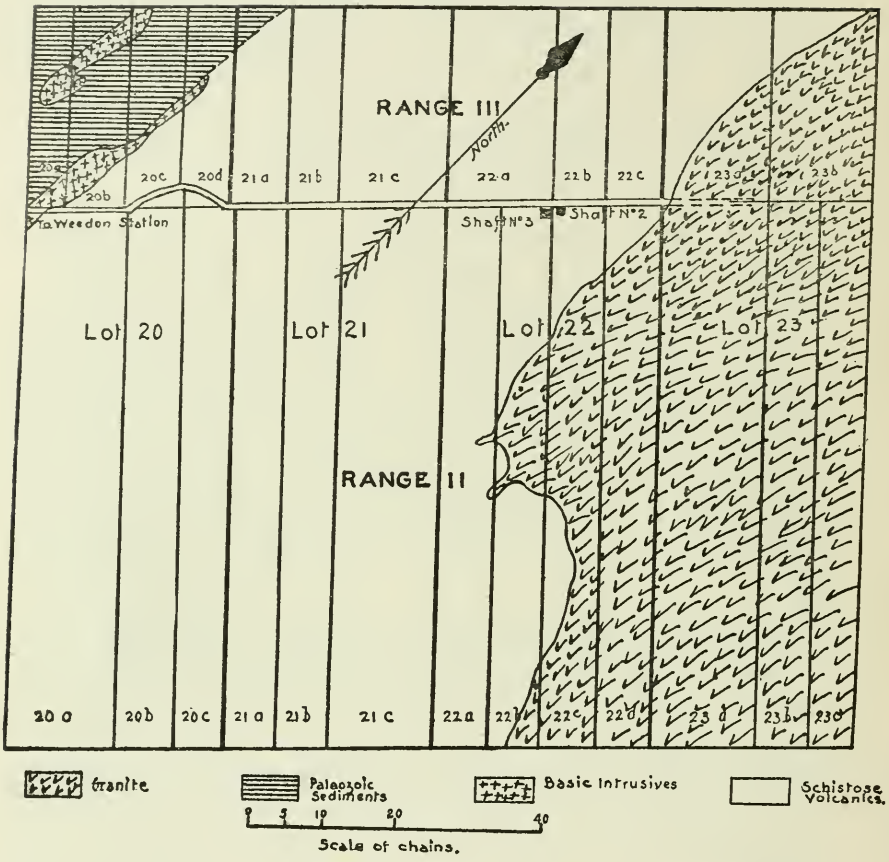

Fig. 1.—Geological Sketch-map of McDonald mine, Weedon.

that with depth, the dip may vary from 35° to 60°. In the Weedon mine, the average dip has proved to be between 40° and 45°. The rocks enclosing the ore body at Weedon are more schistose than those of Stratford. At Weedon, the hanging wall is a sericite schist which originally was probably a quartz-porphyry or quartz-porphyrite, while the footwall is a biotite schist, the biotite of which has been very generally altered to chlorite. At Stratford, at least a very considerable portion of the ore body lies within schistose quartz-porphyry. Both at Weedon and Stratford, the lenticular

ore bodies are dipping towards the margin of the same mass of granite, which in each locality is from 900 to 1,000 feet removed at right angles to their strike and that of the schists into which the granite is intrusive. In both the localities, the granite, for some distance from its contact, displays pegmatitic tendencies, being quite coarse and variable in grain, while the main portion of the mass is biotite-granite, of uniform texture. Where of normal granitoid character, muscovite is often more abundant toward the periphery than toward the interior of the intrusion. At Stratford, between the outcrop of the pyrite and the main contact of the granite body, there are two or three irregular dykes of fresh quartz-porphyry, emanating from the granite and intersecting the schistose volcanic rocks. One of these dykes attains a maximum width of outcrop of about 25 feet. Fine to medium grained, they present a striking appearance, especially on weathered surfaces, because of a well developed spherulitic structure. The spherulites, each less than half an inch in diameter, are closely crowded together and are due to a remarkable radial growth of the feldspar.

From this analysis of the conditions attending the occurrence of these ore deposits, it is evident that the mineralizing solutions that formed them emanated from the granite. Of the numerous so-called prospects for cupriferous pyrite in this area, many of which were several miles removed from the contact of this granite intrusion, those which displayed the best mineralization were in direct association with dykes of granitoid character. That portion of the area within a few thousand feet of this large intrusion of granite, should be prospected very carefully; especially is this true of the more schistose rocks within this distance from the granite. The comparison also suggests that the most favorable portions of the area may be associated with where the granite, in contact with the schists, is rich in muscovite and displays pegmatitic tendencies. From these considerations, as well as from the more hurried examinations of the Eustis, Garthby and other occurrences, it seems probably that in localities where more or less schistose rocks are cut by later intrusives, it is advisable to search thoroughly for deposits of pyrite and cupriferous pyrite.

The McDonald mine is situated on lot 22, range II, in Weedon township. It ranks among the very best of the copper mines that have been developed in the Eastern townships. The main ore body

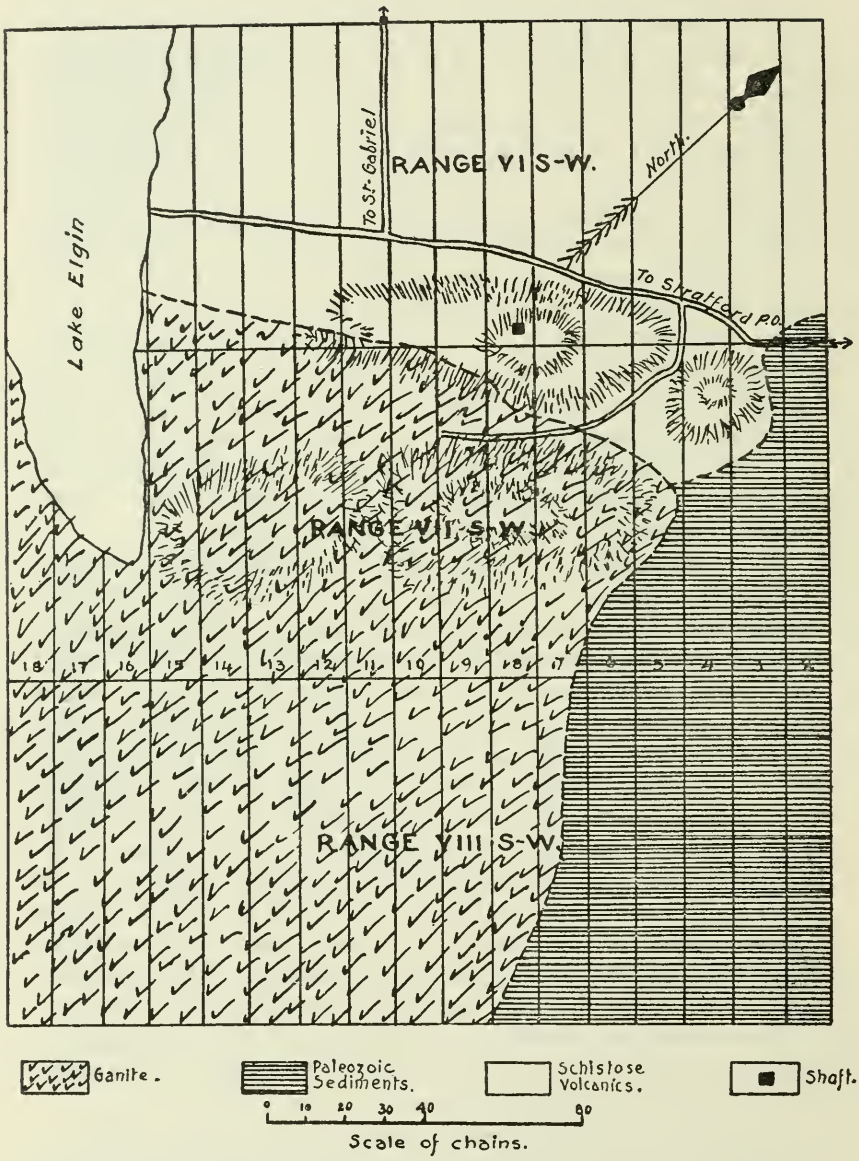

Fig. 2.—Geological Sketch-map of Stratford Pyrite deposit.

is a large, irregularly lenticular mass of solid pyrite with chalcopyrite, some pyrrhotite, scattered grains of zinc blende and a little galena. The last three minerals mentioned are of very subordinate importance in that they form but a relatively small percentage of the whole mass. At the time when this property was examined by the writer, the main ore body had been proved to a length of 570 feet from its north-eastern extremity, and in this distance the maximum width is over forty feet. Its termination towards the south-west had not been determined, as the southern portion of the lens contains lower copper values, up to two and one half per cent., and this was being held in reserve for the present. As is so frequently the case with ore bodies of this type, another similar and smaller lens of ore, several feet in width, had been discovered within the footwall in the upper levels, and this may be expected to attain greater width in some of the lower levels. At the time of my visit, about 200 tons of ore were being shipped daily over an aerial tramway, about 4½ miles in length, which connects the mine with the Quebec Central Railway. A new shaft had been completed almost down to the fifth level. This shaft will permit a great increase in output, and will develop the ore body more nearly in its central portion than the older shaft then in use which penetrates the northern end of the deposit. Not only is the ore body dipping on an average of from 40° to 45° toward the south-east, but it is apparently plunging slightly southward, so that somewhat less ore was being encountered north of the shaft on successively deeper levels. The ore shipped carries on an average of from 4 to 5 per cent. of copper and about 42 per cent. of sulphur. The copper content has remained essentially the same in the lower as in the upper levels of the mine. The copper values are somewhat irregularly distributed, displaying a tendency to be higher along the footwall and in a few places adjacent to the hanging wall. Locally along the footwall, copper values have been found up to as much as from 8 to 20 per cent. This irregularity in the distribution of the copper values is due to the fact that chalcopyrite was deposited after the pyrite, often appearing within the latter in the form of narrow irregular streaks and veinlets.

The Stratford pyrite deposit is located on lot 8, range VI, S.W. of the township of Stratford. It is about six miles distant in a straight line from St. Gérard Station on the Quebec Central Rail-

way. A shaft has been sunk to a depth of 45 feet in the north-eastern end of a lens of solid pyrite. Within three or four feet northward from this shaft, the termination of the lens in this direction is well exposed. In the shaft, the pyrite mass is 5 to 6 feet in thickness; if the shaft had been placed 15 to 20 feet to the south-westward and within the hollow which marks the strike of the ore-body, indications are that it would have penetrated a somewhat greater thickness of ore. In the summer of 1910, a diamond drill was used in prospecting upon this property. Four or five holes were put down and although it is reported that, in at least some of them, several feet of pyrite were encountered, the copper content of the ore was disappointing to those holding the property in lease at that time. In the most southerly of the bore holes, it is said that the ore was found to contain a few per cent. of copper. Undoubtedly the ore body will be found to be quite variable in width when followed along the strike, and although apparently of very much smaller proportions than the Weedon deposit, yet it is a promising prospect which should be most thoroughly investigated.

GOLD AND SILVER.

The production of gold recorded in the table, viz., 738 oz., valued at $14,794, has been derived altogether from the pyritous ores of the Eastern townships. This also applies to the silver production, which figures for 36,392 oz., valued at $21,791.

The alluvial deposits of Beauce did not produce in 1913. A certain amount of prospecting work was done during the summer, but the hydraulic plant was not operated.

Some prospecting was also done on gold-bearing alluvial deposits on Moes river, Compton county; in Chesham township, Frontenac county; and on Felton Brook, Ascot township.

Prospecting and development work were actively carried on in the Kienawisik lake region, where gold was discovered during the summer of 1912. These occurrences were fully described by Dr. Bancroft in the Annual Report for 1912.

IRON.

The iron industry was dormant in the Province of Quebec during the whole of the year 1913. None of the blast furnaces at Drummondville and Radnor were operated, and none of the deposits

of bog iron ore of the St. Maurice region were worked. No production has been recorded since 1911, and the prospect for a resumption of activity in a near future is not of the brightest.

The Canada Iron Corporation, who owns and operated the Drummondville and Radnor furnaces, was placed in the hands of a receiver, pending the re-organization of its finances. This company has large plants and important interests in Ontario, New Brunswick and Nova Scotia, as well as in Quebec. The outstanding securities consist of bonds, $4,637,933; preferred stock, $2,909,000; common stock, $4,832,300. The finances will be reconstructed by reducing fixed charges.

Titaniferous iron ore was shipped from St. Urbain, county of Charlevoix, and from Ivry in Terrebonne county. This ore is used at Niagara Falls, U.S., in the manufacture of ferro-titanium.

CHROMITE.

There has been a slight renewal of interest in chrome mining during 1913, and one company, the Black Lake Asbestos and Chrome Co., Ltd., did a great deal of exploratory work at Black Lake. They put down about 4,000 feet of diamond drilling, and the results obtained are said to have been satisfactory.

The chromite deposits of the Province of Quebec are situated in the serpentine belt, practically all in Coleraine township, in the county of Megantic. Until 1908, they were actively worked, as the accompanying table shows:

CHROMITE PRODUCTION OF THE PROVINCE OF QUEBEC.

Year	Tons	Value
1900	2,068	$33,449
1902	900	13,500
1904	6,429	71,499
1906	8,961	91,834
1907	6,407	63,130
1908	7,564	83,740
1909	2,470	26,604
1910	299	3,734
1911	197	2,469
1912 & 1913	Nil	Nil

Practically the whole of the world's supply of chrome ore comes from Rhodesia and New Caledonia. These two countries in 1912 were responsible for 96% of the world's total production.

"The largest contributor to the world's output of chrome ore is Rhodesia. . . . The present chrome deposits were originally pegged by a prospector in the service of the Selukwe Gold Mining Company. The claims have now been worked for over eight years, and, up to the end of 1912, some 212,267 tons of ore had been mined and exported, against a declared value of £497,984. Until two years ago, no profit return was made to the adventurers, who had slowly and laboriously built up the undertaking, the reasons underlying this untoward state of things being mainly due to the following causes: The attempt by the French group to keep the Rhodesian output off the market—given effect to by continuously lowering the sale price of the ore—and by securing for themselves the contracts, offering by heavy sales ahead at low prices over a period of years, resulting in a consequent reduction of prices—the Rhodesian competitor having on his side to meet the extremely heavy Rhodesian railway, portual and other charges".*

GRAPHITE.

The shipments of graphite from the mines of the Province of Quebec amounted to 103 tons, valued at $9,620. After the hopeful outlook of the previous year, when the value reached $50,680, the result is most disappointing—and there was very little activity in the graphite bearing region, the Buckingham district.

The large mill of the Dominion Graphite Co., erected to treat the product of the Stuart mine, lot 20, range V, Buckingham township, was closed down during the whole year. The same remark applies to the plants of the Buckingham Graphite Co., the Peerless Graphite Co., and the Bell Graphite Co.

The only active operations in that district were carried on by the Quebec Graphite Company on lots 1 to 5, range IV, Buckingham township. This company began development work in 1912, and at present there are two shafts sunk to a depth of 70 feet, and a large amount of stripping. The ore is obtained from open cuts,

**The Mining Journal*, London, Oct. 11th, 1913.

the shafts having been sunk for development work rather than for actual mining.

A new wet process of concentration has been adopted, after a great deal of experimentation, and the mill is said to be giving satisfactory results. This was put in operation late in the year, and worked three months during the latter part of 1913.

The mine of the company, "Graphite Limited," located at St. Rémi d'Amherst, was operated during a part of the year, and the mill, which was completed during the summer of 1913, was started, and some graphite was shipped. But, in December, 1913, the company went into liquidation, and is being re-organized.

The following table gives the output of graphite of the principal producing countries in 1911.

Country	Metric Tons	Value
Austria	41,599	£68,322
Germany	11,298	14,929
Canada	1,151	14,296
Ceylon	27,381	443,754
India	4,112	9,425
Italy	12,821	15,350
Korea	.....	13,506
Madagascar	1,246	9,973
Mexico	2,767	7,470
United States	3,282	59,233

In addition to the above, small productions have been reported from China, France, Japan and Transvaal. (*Mines and Quarries*, Home Office, London.)

LEAD AND ZINC.

Two deposits of lead and zinc ore were actively worked during the year, and shipments of ore were made. One of these deposits, situated near Notre-Dame des Anges, in the county of Portneuf, is worked by Mr. Pierre Tetreault. A short description of the occurrence was given in our report for 1912.

Development work was continued on the Calumet Island deposits, where a new shaft was put down, 100 feet, three compart-

ments, and a considerable amount of drifting work was done. This deposit, which was first opened some twenty years ago, is now worked by the Calumet Zinc and Lead Company, Larawls, Calumet Island, P.Q.

OCHRES.

The shipments of ochre, calcined and raw, reached 5,987 tons, valued at $40,868 in 1913. This is an increase of $8,858 as compared with the previous year.

The whole of the production of ochre in the Province of Quebec comes from deposits situated between Three Rivers and Champlain, on the north shore of the St. Lawrence, at the foot of Lake St. Peter, at Cap la Magdeleine, Red Mill and Champlain.

The greater part of the production of ochre is used in the manufacture of mineral paints, but a certain amount is sent in the raw state to coal gas plants, where it is used as a gas purifier. The ochre is found here occupying old lake basins, and is usually inter-stratified with peat. The thickness of the deposits vary, as well as the quality of the product, but there are very large quantities of this material, which, as a rule, is very high in iron oxide, the calcined material shipped containing over 90% of ferric oxide.

There are numerous other ochre deposits known throughout the province, but only the ones most favourably situated as regards transportation, labour, etc., can be worked. Moreover, the market is limited.

The following is a list of known occurrences of ochre deposits, most of which are of workable size:—

Champlain county.—Several deposits between Three Rivers and Champlain, along the St. Lawrence river. These are the only deposits at present being worked.

St. Maurice county.—Pointe du Lac, St. Nicholas range. These deposits were worked as early as 1851, but subsequently abandoned.

Montmorency county.—At Ste. Anne, one mile and a half above mouth of river, is a remarkable deposit of ochre, several acres in extent, with a maximum depth of 17 feet.

Chicoutimi county.—Simard township, range IV, lots 24 to 26; range V, lots 26 to 28.

Drummond county.—Durham township, range IV, lot 4.

Wright county.—Hull township, range X, lot 15.

Saguenay county.—Iberville township, range III, lots 23, 24, 25.

Vaudreuil county.—Seigniory of Vaudreuil, Côte St. Charles, No. 17.

The term ochre is rather indefinite as regards the composition of that substance. Gardner, in his book "Paint technology and Tests," states that ochre is a hydrated ferric oxide, permeating a clay base. A minimum limit of 20% of iron oxide is given to constitute a good ochre, but there is no line of demarcation between ochres and hydrated or earthy iron ores, such as limonite, ochreous hematite, etc. Some of the ochres of the Province of Quebec are very high in ferric oxide.

MICA.

The sales of mica from mines in the Province of Quebec reached 781,648 lbs., valued at $117,038. Returns of shipments were received from fifteen producers. The increase in the value of shipments in 1913, as compared with 1912, was $17,575, or a proportional increase of 17½ per cent.

The prices are regulated by the size of the plates without flaws which can be cut from the roughly trimmed sheets.

The mica market during the first part of the year was satisfactory, and prices good. During the first few months, the ruling prices were as follows:—

Size, inches.	Price per pound.
1 x 1	5 to 7c
2 x 1	12 " 15c
3 x 1	20 " 25c
3 x 2	45 " 55c
4 x 2	65 " 75c
5 x 3	75 " 90c
6 x 4	$1.00 " $1.15
8 x 5	1.40 " 1.60

Towards the latter part of the year the prices sagged somewhat, and the mica market was more unsatisfactory. This was compensated to some extent by the fact that mica of small size can now be disposed of more easily than formerly. As an instance, two years ago, there was practically no market for 1 x 1 plates, whereas now, they bring in from $100 to $150 a ton.

The greater part of our mica is exported to the United States, and that this market could absorb a much larger quantity is shown by the fact that the imports of mica into the United States in 1912 amounted to 1,989,132 lbs., valued at $748,973.

India, United States and Canada are the three principal mica-producing countries of the world, the annual value of their production being in the order named.

India leads, and the value of its production is nearly twice the combined production of the United States and Canada. In 1911, for instance, the Indian production of sheet mica amounted to 5,200,000 lbs., valued at $918,686, an average of 17 cents a lb., whereas the combined production of sheet mica of the United States and Canada amounted to 3,067,201 lbs., valued at $438,931, or an average of 14 cents a lb. Besides this, the United States produced 3,500 tons of scrap mica, valued at $45,550. The Province of Quebec enters for over 60% in the total mica production of Canada.

KAOLIN.

Active development was carried on in the kaolin deposits near St. Rémi d'Amherst, by the Canadian China Clay Co., Ltd., and some shipments were made to paper manufacturers. The product of this mine is of excellent quality and the paper manufacturers could use a large quantity of it. A great deal of experimenting was carried on in the washing and drying of the kaolin at the plant erected near the mine, and a satisfactory and economic process has been evolved. Some changes are being introduced in the washing plant, and it is expected that during the summer of 1914 the production of kaolin will be continuous and steady.

STRUCTURAL MATERIALS.

The structural materials appear for a preponderating part of the total value of the mineral production of the Province of Quebec. In 1913, their value amounted to $8,187,917, which represents 62% of the total production. Under this heading are grouped cement, limestone, brick, granite, lime, building sand, clay products (tiles, drains, pottery, etc.) in the order of their importance.

CEMENT.

The cement manufactured in the Province of Quebec is exclusively Portland cement. The manufacture of cement is now an exact science, and it is almost impossible to find a natural mixture of clay and limestone which will give the results expected from a Portland cement. The natural cement industry in Canada has been entirely replaced by the manufacture of Portland cement, in which the raw materials are mixed in fixed proportions, according to a strict chemical control.

The composition of Portland cement is therefore definite, and although the mixture of raw materials may vary within narrow limits, it should normally contain 75 per cent of lime carbonate, 13% silica (soluble), 5% alumina, 1½% iron oxide (Fe_2O_3), and the remainder allowed for impurities, magnesium carbonate, alkalies and inert substances. The raw materials used in the Province of Quebec are Trenton limestone exclusively, for the lime constituent, and Utica shale, or Leda marine clay, for the argillaceous component. These substances are very abundant. All along the north shore of the St. Lawrence river deposits of both limestones and clays are common.

In 1913, the cement mills of the Province of Quebec shipped 2,881,480 barrels, valued at $3,361,292. In fact, the value of the cement production was over 40% of the total value of the structural materials.

Ten years ago, in 1904, the recorded production of cement of our province was 40,000 barrels, valued at $66,000.

LIMESTONE.

The limestone industry is well developed in the vicinity of Montreal, where quarries have been opened at Mile End, at Outremont, Côte St. Louis, Longue Pointe, Villeray, Sault-au-Récollet, on beds of the Chazy and the Trenton limestones, both of which are well developed in the Island of Montreal.

At St. Vincent de Paul, St. François de Sales, where a great deal of the limestone is produced, the quarries are in the Trenton. The same formation is also worked at St. Marc des Carrières, Deschambault and Lachevrotière, in Portneuf county, as well as at Beauport and Château Richer, immediately below Quebec. Trenton limestone is also quarried in Hull, opposite Ottawa.

From returns received from producers, the limestone extracted in 1913 reached a value of $1,704,207. This, however, does not represent the whole production, for it is almost impossible to keep track of all the small operators who work spasmodically. From the 162 names of limestone producers to whom we sent return forms to be filled in, only 84 answers were received, many answering only after the second or third request. Of these 84, there were 44 who reported a production, and 40 whose quarries had been idle during the year.

GRANITE.

The Laurentian area, which extends to the north of the Ottawa and St. Lawrence rivers, affords an unlimited supply of granites of various colours and textures, but owing to the limited market, very few quarries have been opened. The main operators in the Laurentian granite are the Laurentian Granite Company, whose quarry is situated at Staynerville, in the county of Argenteuil; M. P. and J. T. Davis, who are working a quarry at Rivière à Pierre, north of Quebec, the stone being used altogether in the construction of the Quebec bridge.

Another source of granite is found in the various igneous intrusions which penetrate the rocks of Ordovician age in the Eastern townships, and large quarries on such occurrences are worked in

the township of Stanstead; in the township of Whitton; on Mount Johnson, near Iberville Junction.

The production of granite reached $496,588 in 1913, as compared with $358,749 in 1912.

OTHER STRUCTURAL MATERIALS.

There are no new developments in the other materials of construction. Brick and lime show very small increases as compared with the previous year, which may be accounted for by the fact that concrete construction is on the increase, as shown by the large increase in the production of cement. The sand which figures in the table of production only represents a very small proportion of the sand actually used in building operations, as we only keep record of the sand which is worked under mining licenses. Most of this sand is dredged or pumped from the beds of rivers.

LIST OF THE PRINCIPAL MINERAL PRODUCERS IN THE PROVINCE OF QUEBEC

ASBESTOS.

The Asbestos & Asbestic Co., Ltd.,
James R. Pearson, Manager, Asbestos, P.Q.

Asbestos Corporation of Canada, Ltd.,
R. P. Doucet, Secretary, 263 St. James St., Montreal.

The Bell Asbestos Mines,
Hon. Geo. R. Smith, V.P. and Manager, Thetford Mines, P.Q.

The B. & A. Asbestos Co.,
J. A. E. Audet, Manager, Robertsonville, P.Q.

The Berlin Asbestos Co., Ltd.,
W. Rumpel, Manager, Rumpelville, P.Q.

Black Lake Asbestos & Chrome Co., Ltd.,
J. E. Murphy, Manager, Black Lake, P.Q.

Frontenac Asbestos Co.,
East Broughton, P.Q.

Jacobs Asbestos Mining Co., of Thetford, Ltd.,
W. R. Leventritt, Mine Superintendent, Thetford Mines, P.Q.

Johnson's Company,
A. S. Johnson, General Manager, Thetford Mines, P.Q.

Ling Asbestos Co.,
J. J. Penhale, Manager, East Broughton, P.Q.

The Martin-Bennett Asbestos Mines, Ltd.,
H. E. Peters, Secretary, Thetford Mines, P.Q.

Robertson Asbestos Mining Co.,
Thetford North, P.Q.

Eastern Townships Asbestos Co.,
P. Anger, Manager, Beauceville, P.Q.

OCHRE.

Thos. H. Argall,
P.O. Box No. 2, Three Rivers, P.Q.

Canada Paint Co., Ltd.,
Jos. Bradley, Manager, Red Mill, P.Q.

Champlain Oxide Co.,
P. D. Carignan, Manager, Three Rivers, P.Q.

Francois Ouellet,
Ste. Gertrude, Co. Nicolet, P.Q.

COPPER.

East Canada Smelting Co., Ltd.,
L. D. Adams, Manager, Weedon, P.Q.

Eustis Mining Co., Ltd.
L. M. Adsit, Manager, Eustis, P.Q.

The Garthby Copper Mining Co.,
T. Lapointe, Manager, Garthby, P.Q.

A. O. Norton,
Wm. Jenkins, Manager, Coaticook, P.Q.

John McCaw,
Sherbrooke, P.Q.

N. S. Parker,
Eastman, P.Q.

MAGNESITE.

Canadian Magnesite Co., Ltd.,
C. L. Higgins, Manager, 708 Eastern Townships Bldg., Montreal.

CHROME.

Black Lake Asbestos & Chrome Co., Ltd.,
J. E. Murphy, Manager, Black Lake, P.Q.

The Dominion Chrome Co.,
A. C. Calder, Manager, 86 Notre-Dame Street, Montreal.

MINERAL WATER.

Abenakis Mineral Springs Co., Ltd.,
W. E. Watt, Manager, Abenakis Springs, P.Q.

Alfred Ferland,
St. Benoit, Co. Deux Montagnes, P.Q.

The Radnor Water Co.,
Geo. C. Kemp, Manager, Mark Fisher Building, Montreal.

Cyp. Roy,
St. Germain, Co. Kamouraska, P.Q.

St. Leon Mineral Water Co.,
St. Léon, Co. Maskinongé, P.Q.

Veuillet & Frere,
St. Geneviève, Co. Batiscan, P.Q.

Bedard & Dion,
22 Avenue Bigaouette, St. Sauveur, Quebec.

PHOSPHATE.

Blackburn Bros.,
H. F. Forbes, Manager, 202 Creighton St., Ottawa.

Electric Reduction Co.,
W. A. Williams, Manager, Buckingham, Co. Labelle, P.Q.

R. J. McGlashan,
W. McGlashan, Manager, Wilson's Corners, P.Q.

O'Brien & Fowler,
Bush Winning, Manager, Cumming's Bridge, Ottawa, Ont.

Progressive Mining Co.,
124 Rideau Street, Ottawa, Ont.

James Cavanagh,
Ottawa, Ont.

IRON.

The Canada Iron Corporation,
Imperial Bank Building, Montreal, P.Q.

International Tool Steel Co., Ltd.,
603 Standard Bank Building, Toronto, Ont.

GRAPHITE.

The Bell Graphite Co., Ltd.,
C. Kendall, Manager, Buckingham, P.Q.

The Buckingham Graphite Co.,
H. P. H. Brumell, Manager, Buckingham, P.Q.

The Canadian Graphite Co.,
T. W. P. Patterson, Manager, 207 Coristine Bldg., Montreal, P.Q

The Dominion Graphite Co.,
H. P. H. Brumell, Manager, Buckingham, P.Q.

Graphite Limited,
220 Board of Trade Bldg., Montreal, P.Q.

The Peerless Graphite Co.,
H. W. Ham, Manager, 64 Clinton Avenue, Rochester, N.Y.

The Quebec Graphite Co., Ltd.,
A. Geister, Manager, Buckingham, P.Q.

MICA.

Wm. Argall,
Laurel, Co. Argenteuil, P.Q.

Blackburn Bros.,
H. L. Forbes, Manager, Ottawa, Ont.

The Capital Mica Co., Ltd.,
W. Ahearn, Manager, Ottawa, Ont.

H. T. Flynn,
108 Montcalm Street, Hull, P.Q.

J. B. Gauthier,
Buckingham, Que.

Kent Bros.,
H. McCadden, Manager, Kingston, Ont.

The Laurentide Mica Co., Ltd.,
Corner Queen and Bridge Streets, Ottawa, Ont.

The Loughborough Mining Company,
Sydenham, Ont.

R. J. McGlashan,
Wilson's Corners, P.Q.

Mica Company of Canada,
Wellington Street, Ottawa, Ont.

O'Brien & Fowler,
Bush Winning, Manager, Cumming's Bridge P.O., Ottawa.

W. L. Parker,
Buckingham, P.Q.

The Vavasour Mining Association,
F. T. Nellis, Manager, 22 Metcalfe Street, Ottawa, Ont.

Wallingford Mica and Mining Co., Ltd.,
E. Wallingford, Manager, Perkins Mills, P.Q.

The Gatineau Valley Mica Co.,
76 Main Street, Hull, P.Q.

Messrs. Cross & Wilson,
Cascades, Que.

William Cleland,
Bouchette, Co. Wright, Que.

Canada Mica Manufacturing Co.,
K. B. Holland, Manager, 81-83 Brewery Street, Hull, Que.

Brown Bros.,
Cantley, Co. Wright, P.Q.

TITANIFEROUS IRON ORE

Baie St. Paul Titanic Iron Ore Mining & Export Co.,
J. O. Paré, Manager, Baie St. Paul, Co. Charlevoix, P.Q.

The Loughborough Mining Co., Ltd.,
G. W. McNaughton, Manager, Schenectady, N.Y.

Manitou Iron Mining Co.,
J. E. Globensky, Manager, Room 50, 364 University St, Montreal, Que.

Canadian Iron Ore Co.,
Jus. Coulombe, Manager, Baie St. Paul, P.Q.

GOLD.

La Compagnie Champs d'Or Rigaud-Vaudreuil, Ltd.,
Room 425, Transportation Bldg., Montreal, Que.

SAND.

Cumming-Lawlor Sand & Supply Co., Ltd.,
H. F. Cumming, Manager, Cor. Ottawa and Seminary Streets, Montreal, Que.

Dominion Sand & Stone Co., Ltd.,
J. E. Levasseur, Manager, 703 Can. Express Bldg., Montreal, Que.

The Montreal Sand & Gravel Co., Ltd.,
J. B. Galarneau, Manager, 270 Ottawa Street, Montreal, Que.

The Touzin Sand Co., Ltd.,
Jos. Touzin, Manager, 1371 Cadieux Street, Montreal, Que.

The Beaupre Sand Co.,
407 St. Valier Street, Quebec.

Alex Bremner, Ltd.,
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Canadian Sand & Gravel Co.,
Richmond Street and Lachine Canal, Montreal, Que.

Compagnie de Sable Union Ltee.,
J. L. Lachance, Manager, 105 Dalhousie Street, Quebec.

Joliette Sand & Gravel Co.,
Joliette, P.Q.

Jules Miller,
81 Grant Street, Quebec.

Moise Robidoux,
Yamaska, P.Q.

Standard Sand & Gravel Co., Ltd.,
P. O. Box 2652, Montreal, Que.

PEAT.

Peat Industries Ltd.,
Imperial Bank Building, Montreal.

SLATE.

New Rockland Slate Co.,
377 St. Paul Street, Montreal, Que.

BRICK.

L. Auger, M.D.,
St. Tite, Co. Champlain, P.Q.

Ernest Beaudet,
St. Jean Deschaillons, P.Q.

Lucien Beaudet,
St. Jean Deschaillons, P.Q.

Zephirin Beaudet,
St. Jean Deschaillons, P.Q.

Jos. Bernier & Cie.,
821 Iberville Street, Montreal.

Narcisse Blais,
12 Marie de l'Incarnation, Québec.

Victor Charland,
St. Jean Deschaillons, P.Q.

Eugene Chretien,
St. Jean Deschaillons, P.Q.

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La Compagnie de Briques de l'Islet Ltd.,
L'Islet, P.Q.

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Ste. Thérèse de Blainville, P.Q.

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Lafontaine & Martel,
St. Tite Co., Champlain, P.Q.

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St. Jean Deschaillons, P.Q.

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Napoleon Loiselle,
Granby, P.Q.

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Sherbrooke, Que.

Mount Royal Brick Co.,
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Ulric Paris,
St. Jean Deschaillons, P.Q.

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Rimouski, P.Q.

St. Lawrence Brick Co., Ltd.,
M. W. Davidson, Manager, Laprairie, P.Q.

Canada Brick Co., Ltd.,
Transportation Building, St. James Street, Montreal, Que.

Alex Mills,
Ormstown, Que.

National Brick Co., Ltd.,
10 Victoria Square, Montreal, Que.

The Montreal Brick,
605 Davidson Street, Montreal, Que.

LIME

Arnaud & Beaudry,
Joliette, Que.

The Dominion Lime Co.,
Marbleton, Co. Wolfe, P.Q.

C. A. Gervais,
1460 Cadieux Street, Montreal, Que.

Z. O. Limoges,
1323 St. Catherine Street East, Montreal, Que.

Olivier Limoges, Sr.,
477 Papineau Avenue, Montreal, Que.

The Montreal Lime Co.,
31 Prenoveau Street, Montreal.

Naud & Marquis,
St. Marc des Carrières, P.Q.

Sovereign Lime Works,
58 St. James Street, Montreal, Que.

Standard Lime Co., Ltd.,
Joliette, P.Q.

Wright & Co.,
Hull, Que.

Missisquoi-Lautz Corporation Ltd.,
631 Coristine Building, Montreal, Que.

The Dominion Lime Co.,
Sherbrooke, Que.

CEMENT.

The Canada Cement Co., Ltd.,
Herald Building, Montreal.

MARBLE.

La Cie. de Marbre du Canada, Ltd.,
St. Thècle, P.Q.

Dominion Marble Co., Ltd.,
Henry Brown, Superintendent, Turcot, Montreal, Que.

The Pontiac Marble Lime Co., Ltd.,
193 Sparks Street, Ottawa, Ont.

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GRANITE.

Argenteuil Granite Co., Ltd.,
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Graniteville, P.Q.

James Brodie & Son,
Iberville, P.Q.

La Compagnie de Granit de Megantic, Ltd.,
Lake Megantic, P.Q.

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St. Sébastien, Co. Frontenac, P.Q.

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Room 94, 224 St. James Street, Montreal, Que.

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Rivière à Pierre, P.Q.

Stanstead Granite Quarries Co., Ltd.,
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Fortunat Voyer,
Rivière à Pierre, P.Q.

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40 Hospital Street, Montreal.

LIMESTONE.

The Chateau Richer Quarry Co.,
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St. Marc des Carrières, P.Q.

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Haney, Miller, Quinlan & Robertson,
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Emile Labelle,
35 Notre-Dame Street West, Montreal, Que.

Louis Labelle & Co.,
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Elz. Laforce,
St. Marc des Carrières, P.Q.

Laurin & Leitch,
5 Beaver Hall Square, Montreal, Que.

Olivier Limoges, Sr.,
477 Papineau Avenue, Montreal, Que.

O. Martineau & Fils, Ltd.,
Alfred Martineau, Mgr., 371 Marie Anne Street, Montreal, Que.

Damase Naud,
St. Marc des Carrières, P.Q.

W. J. Poupore & Co., Ltd.,
124 Board of Trade Building, Montreal, Que.

The Standard Quarries Ltd.,
Room 507, New Birks Building, Montreal, Que.

Rogers & Quirk,
1701 Iberville Street, Montreal, Que.

Joseph Rheaume,
907 Desjardins Avenue, Maisonneuve, Montreal, Que.

Stinson Reeb Builders' Supply Co., Ltd.,
E. T. Bank Building, Montreal, Que.

Wright & Co.,
Hull, P.Q.

Chateauvert Quarry Co.,
St. Marc des Carrières, P.Q.

Mount Royal Tunnel & Terminal Co., Ltd.,
Care of McKenzie, Mann & Co., Ltd., Toronto, Ont.

The St. Laurent Quarry Co., Ltd.,
Cap St. Martin, Co. Labelle, P.Q.

The St. Denis Quarry Co.,
Box 1695, Montreal, P.Q.

J. Dufresne,
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Joliette, P.Q.

The L. Deguire Quarry Co.,
J. A. Crevier, Manager, St. Laurent, near Montreal, P.Q.

David Breault,
St. Jean, P.Q.

La Commission des Champs de Bataille Nationaux,
2 Cook Street, Quebec.

POTTERY.

W. & D. Bell,
1286 St. Valier Street, Quebec.

Canadian Trenton Potteries Co., Ltd.,
W. C. Campbell, Manager, St. John's, P.Q.

G. H. Farrar,
Iberville, P.Q.

The Montreal Terra-Cotta Lumber Co.,
Hubert Desjardins, Manager, Lakeside, P.Q.

The Standard Clay Products Ltd.,
W. C. Trotter, Manager, 157 St. James Street, Montreal, Que.

The Canadian China Clay Co., Ltd.,
J. C. Broderick, St. Rémi d'Amherst, P.Q.

ANNOTATED LIST OF PUBLICATIONS AND REPORTS OF THE MINES BRANCH OF THE PROVINCE OF QUEBEC.

Note.—The Quebec government technical service, in connection with the mines of the Province of Quebec, was initiated in 1881 with the appointment of Mr. J. Obalski, Mining Engineer, graduate of L'Ecole Nationale des Mines de Paris. His first published report on the mines of the Province of Quebec was printed as part of the report of the Crown Lands Commissioner for the year 1883. Previous to Mr. Obalski's appointment, the reports of the Crown Lands Department give, yearly, a few paragraphs by the Mining Inspector, a non-technical officer, whose chief duty was the collection of mining license fees, and of the royalty on the gold extracted from the alluvial workings of the Chaudière valley.

REPORT OF CROWN LANDS COMMISSIONER OF THE PROVINCE OF QUEBEC FOR YEAR ENDING JUNE, 1883.

NOTES ON MINERAL PRODUCTS OF THE PROVINCE OF QUEBEC (26pp)

This gives a short geological sketch, of one page, and notes on each of the economic minerals of the province. This information, as stated in the introduction, is a compilation from the Geological Survey Reports, from private reports to which the author had access, and from field-work by himself.

Iron Ores.—Magnetite in counties of Megantic, Terrebonne, Ottawa, Sherbrooke, Beauce and other minor occurrences. Magnetic sands of north shore of St. Lawrence. Hematite in counties of Ottawa, Sherbrooke. Titanic iron ores in counties of Charlevoix, Saguenay and other occurrences mentioned. Limonite in counties of Champlain, St. Maurice and other occurrences mentioned.

Manganese Ore.—Magdalen Islands and other occurrences mentioned.

Copper Ore.—General notes on Eastern townships ores. Occurrences in Lake St. John region and on the north shore of St. Lawrence.

Nickel and Cobalt.—Occurrences, not of economic importance.

Lead Ores.—Occurrences mentioned at Lake Temiskaming; in counties of Rimouski; Sherbrooke; Bellechasse; Gaspé.

Zinc Ores.—Occurrences mentioned, but said not to be of economic importance.

Antimony.—In Wolfe county.

Silver Ores.—Presence of silver mentioned in ores of copper, of lead and complex ores.

Gold.—Alluvial deposits of Beauce. Lode gold in upper part of Chaudière river.

Molybdenite.—Occurrences at Manicuagan; Harvey Hill; Ottawa county.

Graphite.—Buckingham; also in graphitic shales in Richmond and Shefford.

Asbestos. — Deposits and mines of Coleraine and Thetford. Occurrences in Templeton township.

Ochre.—Various deposits mentioned but not described.

Phosphate of Lime.—Apatite deposits of Ottawa county.

Oil.—Occurrences of oil and bituminous matter.

Peat.—Various deposits of peat mentioned, but not described.

Chromite.—Occurrences mentioned.

Mica.—Mentioned as occurring in Argenteuil, Berthier, Joliette, Ottawa, Megantic and Quebec.

Structural Materials.—Limestone, marble, lithographic stone, sandstone, slate, granite, labradorite, serpentine, clay, sands and mineral springs are mentioned.

REPORT ON A LANDSLIDE AT THE HEAD OF THE GRAND RIVER YAMACHICHE (ST. MAURICE) (3 p.)—Account of landslide which occurred in range VIII, in south-west part of Shawenegan township, which displaced an estimated quantity of 80,000,000 cubic feet of ground.

REPORT OF AN EXPLORATION IN THE COUNTY OF BELLECHASSE.—Notes on Geology and mineral deposits.

REPORT OF EXPLORATION ON NORTH SHORE OF ST. LAWRENCE FROM SAGUENAY RIVER TO LA POINTE MARGUERITE (6 p.)—Notes on Geology, Ochre deposits of Petite Romaine; Ilets Jérémie; Manicuagan and Pointe des Monts.

REPORT OF EXPLORATION IN THE COUNTIES OF BROME, SHEFFORD, RICHMOND (4 p.)—Iron mines in Sutton township. Copper at Knowlton; at Brompton. Sulphur spring in Potton.

REPORT ON MINERAL SPRING AT STE. ANNE DE LA PERADE (1 p.)

EXPLORATIONS IN THE PHOSPHATE REGIONS OF OTTAWA COUNTY (5 pp.)—Description of deposits and mines.

EXPLORATIONS ON THE GATINEAU (1 p.)—Mineral occurrences in the Gatineau region.

EXPLORATION IN MONTMORENCY COUNTY, INCLUDING ISLAND OF ORLEANS.—Occurrences of bituminous limestone and anthraxolite.

REPORT ON OCCURRENCES OF COPPER, MOLYBDENUM, AND LABRADORITE ON THE SOUTH SHORE OF THE GULF OF ST. LAWRENCE (4 pp.)—H. de Puyjalon describes copper, molybdenite, mica occurrences at Watshishou river, and labradorite along the coast.

REPORT OF THE COMMISSIONER OF CROWN LANDS FOR YEAR ENDING JUNE, 1884.

NOTES ON MINING IN 1884 AND FIGURES OF EXPORTS OF ORES (3 pp.)

REPORTS ON OIL AND GAS OCCURRENCES IN VALLEYS OF ST. LAWRENCE AND ST. MAURICE RIVERS; AT ST. GREGOIRE; AT ST. HENRI DE MASCOUCHE (4 pp.)—It is pointed out that the gas emanations in these places may have their source in underlying occurrences of petroleum.

REPORT OF EXPLORATION IN PONTIAC COUNTY (3 pp.)—Mineral occurrences in townships of Onslow, Bristol, Litchfield, Calumet Island, Mansfield, Waltham, Leslie, Cawood and Thorne.

REPORT OF EXPLORATION IN THE COUNTIES OF MEGANTIC AND LOTBINIERE.—Coaly substance at Ste. Sophie; at St. Apollinaire. Asbestos in Ireland township. Copper in Halifax township.

REPORT OF EXPLORATION IN THE REGION OF UPPER SAGUENAY AND LAKE ST. JOHN (4 pp.)—Beryl in Jonquière. Red granite at Hébertville. Limestone in township of Caron. Bituminous schist on Lake St. John. Titaniferous iron ore in Bourget township.

EXPLORATION FOR MINERALS ON NORTH SHORE OF GULF OF ST. LAWRENCE (7 pp.)—By H. de Puyjalon. Copper at Watshishou Beryl, tourmaline, moonstone. Limestone on Mingan Islands. Limestone at Seven Islands. Limestone at Pentecôte river.

REPORT OF COMMISSIONER OF LANDS & FORESTS FOR YEAR ENDING JUNE, 1885.

REPORT ON THE PHOSPHATE OF LIME AND MICA DEPOSITS OF THE COUNTY OF OTTAWA (12 pp.)—Notes and descriptions of occurrences and mines and analyses. Costs of mining and shipping phosphates. Mica mines in various parts of Province.

REPORT ON NATURAL GAS IN VALLEY OF ST. LAWRENCE (4 pp.)—Gas well at St. Grégoire. Log of well. Occurrences at Contrecoeur, St. Barnabé and Longue Pointe.

REPORT OF COMMISSIONER OF CROWN LANDS FOR YEAR ENDING JUNE, 1886.

REPORT ON ASBESTOS MINES OF EASTERN TOWNSHIPS (6 pp.)—Description of occurrences and mines in townships of Thetford, Coleraine, Broughton, Wolfestown, Shipton.

REPORT OF COMMISSIONER OF CROWN LANDS FOR YEAR ENDING JUNE, 1887.

REPORT ON NATURAL GAS (15 pp.)—Gives results of visit to Pennsylvania and Ohio. Describes Findlay field, piping of gas, uses. Gives a short account of occurrences of gas in the Province of Quebec.

REPORT OF CROWN LANDS COMMISSIONER FOR YEAR ENDING JUNE, 1888.

NOTES ON MINES AND MINERALS, ON MINING INDUSTRY (8 pp.)—Natural gas, logs of wells at Maisonneuve, Louiseville and St. Grégoire.

Gold in Beauce, particularly lode gold.
Asbestos in Coleraine, Black Lake and Danville.
Phosphates, mica and graphite in Ottawa region.

EXPLORATIONS ON ST. MAURICE AND MATTAWAN RIVERS (5 pp.)—Notes on occurrences of mica, phosphates, iron, graphite and gold.

EXPLORATIONS IN PONTIAC COUNTY (2 pp.)—Notes on Temiskaming lead mine; Bristol iron mine, phosphates.

STATISTICS.—Production for 1887 and previous years.

REPORT OF CROWN LANDS COMMISSIONER FOR YEAR ENDING JUNE, 1889.

MINING OPERATIONS.—Notes on year's work and development, in gold, asbestos, phosphates, copper, etc.

REPORT ON EASTERN PART OF GASPESIA (2 pp.)—Mentions gold, copper, galena; gold on Dartmouth river; oil on York and St. John rivers.

REPORT OF CROWN LANDS COMMISSIONER FOR YEAR ENDING JUNE, 1890.

MINING OPERATIONS AND STATISTICS (12 pp.)—Notes on mines and development, iron, copper, lead, gold, natural gas, asbestos, etc.

MINES AND MINERALS OF THE PROVINCE OF QUEBEC (170 pp.)

Report published in 1889, being a compilation of all data of economic nature on the mineral deposits and occurrences in the Province of Quebec. The information was mainly taken from the Geological Survey reports; from the reports of the Department of Crown Lands and from private reports and investigations. The information is given under the headings of the various substances.

REPORT OF COMMISSIONER OF CROWN LANDS FOR YEAR ENDING JUNE, 1891.

REPORT ON MINING OPERATIONS AND STATISTICS.—Notes on establishment of six mining divisions and appointment of inspectors.

REPORT OF COMMISSIONER OF CROWN LANDS FOR YEAR ENDING JUNE, 1894 (24 pp.)

REPORT ON MINING OPERATIONS DURING YEAR, WITH SPECIAL MENTION OF CHROMITE.

REPORT OF COMMISSIONER OF CROWN LANDS FOR YEAR ENDING JUNE, 1895 (20 pp.)

REPORT ON MINING OPERATIONS DURING YEAR.

REPORT OF COMMISSIONER OF CROWN LANDS FOR YEAR ENDING JUNE, 1896 (7 pp.)

REPORT ON MINING OPERATIONS DURING YEAR.

REPORT OF COMMISSIONER OF COLONIZATION AND MINES FOR YEAR ENDING JUNE, 1897.

MINING OPERATIONS IN THE PROVINCE OF QUEBEC IN 1897 (30 pp.)

Special notes on Titaniferous ores; Chromite; Lead on Calumet Island; Gold in Beauce; Mica; Feldspar.

EXPLORATION OF MOUNT ALBERT, GASPÉ (2 pp.)

REPORT OF COMMISSIONER OF COLONIZATION AND MINES FOR YEAR ENDING JUNE, 1898

SUMMARY REPORT ON MINING OPERATIONS (4 pp.)

MINERAL OCCURRENCES ON NORTH SHORE (13 pp.)

Notes on Mineral deposits between Pointe aux Esquimaux and Pointe à Giroux. Marble, Iceland Spar, Mica, Molybdenite, Feldspar, Copper.

CHROMIC IRON IN THE PROVINCE OF QUEBEC.

Published by Dept. of Colonization and Mines, 1898.

Report of 30 pages on deposits and occurrences of Chromite in Eastern townships, with descriptions of mining methods, statistics, uses, concentration, etc.

GOLD IN THE PROVINCE OF QUEBEC.

Published by Dept. of Colonization and Mines, 1898.

Report of 82 pages and map, on Gold in Beauce county, in placer deposits and in lodes. Also description of occurrences in Dudswell district; in Ditton township; and near Sherbrooke.

REPORT ON THE MINES OF THE PROVINCE OF QUEBEC FOR THE CALENDAR YEAR, 1898.

Department of Colonization and Mines.

Report of 58 pages on the Mining Industry in 1898, with special notes on Chromite, Lead and Zinc, Mica—and Statistics.

REPORT OF COMMISSIONER OF COLONIZATION AND MINES FOR YEAR ENDING JUNE, 1899.

SUMMARY REPORT ON MINING OPERATIONS (4 pp.)

REPORT ON THE MINES OF THE PROVINCE OF QUEBEC FOR THE CALENDAR YEAR OF 1899.

Department of Colonization and Mines.

Report of 50 pages on mining in Quebec in 1899, with special notes on deposits, and occurrences of Iron, Mica, Oil in Gaspé.

REPORT OF COMMISSIONER OF COLONIZATION AND MINES FOR YEAR ENDING JUNE, 1900.

SUMMARY REPORT OF MINING OPERATIONS (4 pp.)

REPORT OF MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR CALENDAR YEAR 1900.

Department of Colonization and Mines.

NOTES ON THE VARIOUS MINING INDUSTRIES AND STATISTICS (37 pp.)

REPORT OF COMMISSIONER OF COLONIZATION AND MINES FOR YEAR ENDING JUNE, 1901.

SUMMARY REPORT OF MINING OPERATIONS (3 pp.)

MICA, IN THE PROVINCE OF QUEBEC.

Department of Colonization and Mines, 1901.

Report of 63 pages on Mica occurrences in the province—mining, uses, statistics, etc.

MINING OPERATIONS IN THE PROVINCE OF QUEBEC, CALENDAR YEAR 1901.

Department of Lands, Mines and Fisheries.

Report of 47 pages on the mining operations in 1901, with notes on iron sands, concentration, copper occurrences, etc.

REPORT OF MINISTER OF CROWN LANDS, MINES AND FISHERIES FOR YEAR ENDING JUNE, 1902.

SUMMARY REPORT OF MINING OPERATIONS (4 pp.)

MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR CALENDAR YEAR 1902 (49 pp.)

NOTES ON MINES AND MINING INDUSTRY DURING THE YEAR.
MAGNETIC CONCENTRATION OF IRON ORES.

REPORT OF MINISTER OF CROWN LANDS, MINES AND FISHERIES FOR YEAR ENDING JUNE, 1903.

SUMMARY REPORT OF MINES BRANCH FOR FISCAL YEAR (3 pp.)

REPORT ON MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR CALENDAR YEAR 1903.

Department of Lands, Mines and Fisheries.

Report on mining operations, with special chapters on magnetic sands, briquetting and concentration; chromic iron occurrences, mines, concentration and uses; copper at Matane; Mica; radioactive minerals, cleveite from Pied des Monts; gypsum and manganese, Magdalen Islands. (85 pp.)

REPORT OF MINISTER OF CROWN LANDS, MINES AND FISHERIES FOR YEAR ENDING JUNE, 1904.

SUMMARY REPORT OF A TRIP TO LAKE CHIBOUGAMAU (3 pp.)

Short account of trip taken by Mr. Obalski to Chibougamau in summer of 1904, and of mineral occurrences.

SUMMARY REPORT OF MINES BRANCH (3 pp.)

MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR CALENDAR YEAR OF 1904.

Department of Lands, Mines and Fisheries.

REPORT OF MINING OPERATIONS (24 pp.)

EXPLORATION ON LAKE CHIBOUGAMAU REGION (20 pp.)

Account of trip by Mr. Obalski. Occurrences of gold, copper, asbestos, iron. Local geology. Map and illustrations.

REPORT OF MINISTER OF LANDS, MINES & FISHERIES FOR YEAR ENDING JUNE, 1905.

SUMMARY OF MINES BRANCH FOR YEAR (3 pp.)

MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR CALENDAR YEAR 1905.

Department of Colonization, Mines and Fisheries.

REPORT ON MINING OPERATIONS.

General notes on mining industry and statistics in 1905. (17 pp.)

CHIBOUGAMAU MINING DISTRICT.

Geological description. Extracts from report by J. E. Hardman. Occurrences of economic minerals. (15 pp.)

RARE EARTHS IN THE PROVINCE OF QUEBEC.

Annotated list of occurrences in the Province of Quebec, by H. Nagant. (5 pp.)

REPORT OF MINISTER OF COLONIZATION, MINES AND FISHERIES FOR YEAR ENDING JUNE, 1906.

SUMMARY REPORT OF MINES BRANCH (3 pp.)

Notes on development of industry, and on the new districts of Chibougamau and Temiscamingue.

MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR THE YEAR 1906.

EXPLORATION TO THE NORTH OF THE COUNTY OF PONTIAC (25 pp.)

Report of two months' field-work by J. Obalski, from Ville-Marie to Harricanaw. Geology, physiography and mineral deposits. With map.

NOTES ON CHIBOUGAMAU DISTRICT (3 pp.)

NOTES ON MINING OPERATIONS IN 1906 (28 pp.)

REPORT OF MINISTER OF COLONIZATION, MINES AND FISHERIES FOR YEAR ENDING JUNE, 1907.

SUMMARY REPORT OF MINES BRANCH (7 pp.)

MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR YEAR 1907.

REPORT ON MINING IN 1907 AND STATISTICS (30 pp.)

Special reference to hematite in Dunham township; to magnetite in Beauce; to gold in Marston township; to natural gas at Louisville and its exploitation.

EXPLORATION IN NORTHERN PONTIAC (16 pp.), WITH MAP.

Exploration by Mr. J. Obalski in the Abitibi region.

REPORT OF MINISTER OF COLONIZATION, MINES AND FISHERIES FOR YEAR ENDING JUNE, 1908 (5 pp.)

SUMMARY REPORT OF MINES BRANCH.

MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR YEAR 1908.

NOTES ON MINING IN 1908 AND STATISTICS (30 pp.)

Special reference to magnesite in Argenteuil.

REPORT ON AN EXPLORATION OF MANICOUAGAN AND OUTARDE RIVERS (29 pp.)

Exploration by J. H. Valiquette. Physiography, natural resources, geology.

REPORT OF AN EXPLORATION IN THE CHIBOUGAMAU REGION

Notes on a two months' exploration by E. Dulieux. Describes routes followed, geology and mineral resources of region. (35 pp.)

REPORT OF MINISTER OF COLONIZATION, MINES AND FISHERIES FOR YEAR 1909.

SUMMARY OF MINES BRANCH FOR FISCAL YEAR ENDING JUNE, 1909 (4 pp.)

PRELIMINARY STATEMENT OF MINERAL PRODUCTION OF THE PROVINCE OF QUEBEC FOR 1909.

MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR CALENDAR YEAR 1909 (34 pp.)

Review of mining operations, with special mention of amendments to the Mining Law, and of accidents in mines.

REPORT OF MINISTER OF COLONIZATION, MINES AND FISHERIES FOR YEAR ENDING JUNE, 1910.

SUMMARY OF MINES BRANCH FOR FISCAL YEAR (7 pp.)

PRELIMINARY REPORT ON THE GEOLOGY AND MINERAL RESOURCES OF THE CHIBOUGAMAU MINING REGION (24 pp.)

Report by the Commission appointed to investigate the mineral possibilities of the Chibougamau region, more especially from the standpoint of building a railway into the district.

PRELIMINARY STATEMENT OF MINERAL PRODUCTION FOR THE YEAR 1910 (5 pp.)

NOTES ON SOME GOLD BEARING VEINS IN THE NORTHERN PART OF PONTIAC COUNTY.

By R. Harvie (6 pp.)

Leaflet issued to guide prospecting, distinguishing between the quartz veins cutting the Laurentian, which are usually barren, and quartz veins cutting the Keewatin, which are more liable to be gold-bearing.

REPORT ON MINING OPERATIONS FOR CALENDAR YEAR 1910 (110 pp.)

REPORT ON MINING INDUSTRY IN 1910.

Geology of Thetford District, by J. A. Dresser. Asbestos in other countries. Extracts of reports on Titaniferous ores of Quebec. Graphite mines and mills of the Province of Quebec. Natural gas at St. Barnabé. Accidents in mines.

GEOLOGY AND MINERALOGY OF LAKE OPASATICA DISTRICT

By R. Harvie (9 pp.)

GEOLOGY OF A PART OF GASPÉ PENINSULA.

By A. Mailhiot (9 pp.)

GEOLOGY OF THE TOWNSHIP OF FABRE, IN THE COUNTY OF PONTIAC.

By Robert Harvie.

Report on the Geology of Fabre and Mineral deposits. With map on scale of $\frac{1}{2}$ mile to the inch. (35 pp.)

GEOLOGY AND MINERAL RESOURCES OF THE CHIBOUGAMAU REGION.

By the Chibougamau Commission (224 pp. and 2 maps).

Detailed report of the Chibougamau Mining Commission. Geology, petrography and mineral resources. Dr. A. E. Barlow, chairman, Prof. J. C. Gwillim and E. R. Faribault were the members of the Commission.

REPORT OF THE MINISTER OF COLONIZATION, MINES AND FISHERIES FOR THE YEAR ENDING JUNE, 1911.

SUMMARY REPORT OF MINES BRANCH (5 pp.)

PRELIMINARY STATEMENT OF THE MINERAL PRODUCTION FOR THE YEAR 1911 (9 pp.)

MINING OPERATIONS IN THE PROVINCE OF QUEBEC DURING THE YEAR 1911 (212 pp.)

REVIEW OF MINING OPERATIONS AND MINING ACCIDENTS (32 pp.)

REPORT ON MONTREAL QUARRIES.

By J. H. Valiquette (20 pp.)

REPORT ON IRON DEPOSITS ON NORTH SHORE OF ST. LAWRENCE RIVER.

By Prof. E. Dulieux (88 pp.)

This is the result of three months' field-work. Gives description, geology and mode of occurrence of Titaniferous deposits of St. Urbain; Seven Islands, Rapid River; Margaret River; Chaloupe River; Cap Rond; Thunder River; St. John River; Moisie.

REPORT OF THE GEOLOGY AND MINERAL RESOURCES OF KEEKEEK AND KEWAGAMA LAKES REGION.

By Dr. J. A. Bancroft (48 pp.)

Report of field-work in North Pontiac county, south of transcontinental railway, in the projected townships of Joanne, Bousquet, Cadillac and Clericy. Description of deposits and geology of mineral deposits of Keekeek Lake, and of molybdenite and bismuthenite deposits of Kewagama.

REPORT OF MINISTER OF COLONIZATION, MINES AND FISHERIES FOR YEAR ENDING JUNE, 1912.

SUMMARY REPORT OF MINES BRANCH (4 pp.)

GEOLOGY AND NATURAL RESOURCES OF THE BASINS OF HARRICANAW AND NOTTAWAY RIVERS.

By Dr. J. A. Bancroft (16 pp.)

Preliminary report of an exploration north of the Transcontinental Railway, down part of the Harricanaw and up the Nottaway and Natagagan Rivers.

PRELIMINARY REPORT ON THE MINERAL PRODUCTION OF THE PROVINCE OF QUEBEC FOR YEAR 1912. (8 pp.)

REPORT ON UNGAVA, RECENTLY ANNEXED TO THE PROVINCE OF QUEBEC UNDER THE NAME OF "NEW QUEBEC."

With Geological Map (160 pp.)

Compilation of extracts from reports previously published; preceded by an account of the steps taken for the annexation. The information which embraces the geology, physiography, water powers, fauna, flora, mineral resources, fisheries, etc., is mainly taken from the reports of the Geological Survey.

REPORT ON THE MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR THE YEAR 1912 (242 pp.)

REVIEW OF MINING OPERATIONS AND ACCIDENTS IN MINES (65 pp.)

REPORT ON SOME IRON ORE DEPOSITS IN THE PROVINCE OF QUEBEC, by E. Dulieux (65 pp.)

Descriptions of Iron deposits of Beresford township, Terrebonne county; St. Boniface, St. Maurice county; Bourget township, Saguenay; Kénogami township, Saguenay county; Beauceville deposits, Beauce county; Leeds township; Spalding township, Compton county; vicinity of Ottawa; Gaspé Peninsula; Batiscan, Champlain county.

REPORT ON GEOLOGY AND NATURAL RESOURCES OF PORTIONS OF BASINS OF HARRICANAW AND NOTTAWAY RIVERS, TO THE NORTH OF THE TRANSCONTINENTAL RAILWAY.

By Dr. J. A. Bancroft (67 pp.), with map.

Accounts of topography, water powers, soil, climate, flora, fauna, geology, mineral resources of the basins of these rivers, between the National Transcontinental Railway and James Bay.

REPORT ON THE GEOLOGY AND NATURAL RESOURCES OF REGION OF HEADWATERS OF HARRICANAW RIVER.

By Dr. J. A. Bancroft (37 pp.), with map.

Description of gold bearing deposits of Lake Kienawisik; of molybdenite deposits of Lake Kewagama.

REPORT OF MINISTER OF COLONIZATION, MINES AND FISHERIES FOR YEAR ENDING JUNE, 1913.

SUMMARY OF MINING OPERATIONS (6 pp.)

PRELIMINARY STATEMENT ON THE MINERAL PRODUCTION OF THE PROVINCE OF QUEBEC DURING THE CALENDAR YEAR 1913 (8 pp.)

INTERNATIONAL GEOLOGICAL CONGRESS.[1]

EXCURSIONS IN THE PROVINCE OF QUEBEC.

JULY AND AUGUST, 1913.

Excursion A1.

QUEBEC AND MARITIME PROVINCES.

Leader:—G. A. Young.

Participants.

Dr. Adams, Canada; Mrs. Adams; Andrée, Germany; Arlt, Germany; Bailey, Canada; Baker, Canada; Bancroft, Canada; Barlow, Canada; Barrows, U.S.A.; Bell, Canada; Boden, Germany; Bowmann, England; Brock, Canada; Burling, Canada; Cantley, Canada; Cadell, Scotland; Caillebotte, France; Carruthers, Scotland; Chambers, Canada; Cole, Canada; Cushing, U.S.A.; Denis, Canada; Eckfeldt, U.S.A.; Gardner, Scotland; Goldman, U.S.A.; Goldthwait, Canada; Abbé Guimont, Canada; Gürich, Germany; Haniel, Germany; Hartnagel, U.S.A.; Haycock, Canada; Hayes, U.S.A.; Hayward, England; Henderson, England; Hobson, England; Holbrook, Canada; Holtedahl, Norway; Hore, Canada; Howley, Newfoundland; J. Hurll, Scotland; M. Hurll, Scotland; Hyde, Canada; Jehu, Scotland; Jennison, Canada; Kido, Japan; Kindle, Canada; Kummell, U.S.A.; Lambe, Canada; Lawson, U.S.A.; Lecky, Canada; Lory, France; Martius, Germany; Matthew, Canada; McPherson, Canada; Michalon, France; Mitscherlich, Germany; Nicholas, England; Part, England; Paulcke, Germany; Piers, Canada; Powers, U.S.A.; Pruvost, France; Quensel, Sweden; Miss Rathgen, Germany; Raymond, U.S.A.; Riedel, Germany; Saint-Clivier,

[1] Extracts from "Comptes-Rendus du XIIème Congrès Géologique International, Canada, 1913."

France; Sanders, Canada; Schuchert, U.S.A.; Sexton, Canada; Stevens, Canada; Strahan, England; Stolley, Germany; Termier, France; Mlle. Termier, France; Tillman, Germany; Tolmacef, Russia; Twenhofel, U.S.A.; Ulrich, U.S.A.; Von Grote, Germany; Welter, Germany; Weigand, Germany; Wigglesworth, U.S.A.; Woodworth, U.S.A.; Wordie, England; Wright, Canada; Zoude, Belgium; Zuber, Austria.

This excursion was to enable the participants to obtain a general idea of the geology of eastern Canada. The first group of rocks of interest after leaving Montreal is the Quebec group, which is so well developed in the vicinity of Quebec and Lévis.

Leaving Montreal on July 13th, the special train of six sleeping cars, two dining cars and the necessary baggage cars, arrived in Lévis, opposite Quebec city, on the morning of July 14th. At 8.30 a start was made from the train to examine the Lévis formation, of which 1,000 feet are exposed in the cliff which overlooks the shore of the river. Numerous specimens of graptolites were obtained.

By street cars, the party then went to Hadlow, west of the city of Lévis, to examine the Sillery sandstones and shales.

At 11.30, the geologists crossed the river by ferry, and proceeded by special electric car to the Montmorency station, where they were welcomed by his worship, the Mayor of Quebec, and a committee of Quebec citizens, with Sir George Garneau as chairman. A lunch at the Kent House, offered by the local committee, was presided over by Sir George Garneau, having on his right the President of the Geological Congress, and on his left his worship Mayor Drouin.

After lunch, the geology of the vicinity of the Montmorency Falls was examined, beginning at the base of the falls, and all the rocks were reviewed, the pre-Cambrian gneiss, the Trenton, Utica and Lorraine, all exposed in a section in the bluff (320 feet high) which gives rise to the falls. A special feature was the splendid contact of deposition between the Trenton limestone and the pre-Cambrian gneiss. In one place, Trenton corals are seen attached to the gneissic floor.

At four o'clock, the geologists and the members of the local reception committee took a drive in Quebec city and vicinity to see the points of local interest.

In the evening, a reception was held in the halls and museum of Laval University. The visitors were received and greeted by his honour the Lieutenant Governor of the Province of Quebec, Sir Francois Langelier, and by Monseigneur Gosselin, rector of the University.

In the morning of the 15th the special train proceeded to Rivière du Loup, Bic, where stops were made to further examine the Quebec group.

The following days were entirely given to the Gaspé peninsula, where the Palæozoic strata and the Appalachian structure were studied at Percé, Gaspé and Grande Grève. A long stop was made on the return trip, at Scaumenac bay, where collections of Devonian fish remains were made.

Excursion A5.

GEOLOGY AND MODE OF OCCURRENCE OF THE ASBESTOS AND CHROME DEPOSITS OF THE PROVINCE OF QUEBEC.

Leaders:—J. A. Dresser and T. C. Denis.

Participants.

Archinow, Russia; Arlt, Germany; Bain, U.S.A.; Belowsky, Germany; Bergeat, Germany; Berkey, U.S.A.; Boden, Germany; Boggild, Denmark; Buggenoms, Belgium; Denis, Canada; Dresser, Canada; Drugman, Belgium; Fabrega, Spain; Fermor, India; Frechette, Canada; Geiger, Sweden; Grote, Germany; Gurich, Germany; Harvie, Canada; Hore, Canada; Howley, Newfoundland; Hurll, M., Scotland; Hurll, J. M., Scotland; Kosu, Japan; Krusch, Germany; Mailhiot, Canada; Murray, England; Palache, U.S.A.; Prindle, U.S.A.; Quensel, Sweden; Searls, U.S.A.; Visconte, Russia; Wallis, England; Welter, Germany; Wherry, U.S.A.; Wigglesworth, U.S.A.; Wilbraham, England; Wolff, U.S.A.; Zoude, Belgium.

The object of this excursion was to afford the opportunity of examining the outcrops and the relations of the various rocks which constitute the serpentine belt of the Province of Quebec, and which contain the asbestos and the chromite deposits. The asbestos deposits are worked on a very large scale. The actual leader of this excursion was Mr. J. A. Dresser.

A special train of five cars left Montreal at 10.30 Saturday evening, August 2nd, arriving at Black Lake, 163 miles distant, early on Sunday morning. All day Sunday was spent on the geology of Black Lake and vicinity. On Monday morning, August 4th, fifteen carriages, a most hetèrogeneous collection, conveyed the excursionists on a drive of fourteen miles to the chromite deposits, known as "Montreal Pit," near the Little Lake St. Francis. On Tuesday morning the excursion went by train to East Broughton, twenty miles north of Black Lake, to examine the asbestos deposits of that district, which are unlike those of Thetford and Black Lake. Tuesday noon the train returned to Thetford, four miles north of Black Lake, where the asbestos quarries and the asbestos mills were visited.

Wednesday morning, August 6th, we left Thetford on the return journey. A stop of one hour and a half was made at Coleraine to examine the outcrops of the contact breccia between the batholitic intrusions and the sedimentary rocks. Sherbrooke was reached at two o'clock, where automobiles, which were put at our disposal by a local committee of citizens, gave the opportunity of seeing the city of Sherbrooke and to visit one of its large manufactures. The train left Sherbrooke at four o'clock, to reach Montreal at eight, and Toronto the next morning at seven o'clock.

The rocks which were examined during excursion A. 5 belong to a belt or zone of basic intrusions, having a general strike N.E.-S.W., and which is more or less continuous from the Vermont boundary line to the Chaudière River, a distance of 200 kilometres; its maximum width is 10 kilometres. It is composed of peridotites, gabbros, diabases, porphyrites, hornblende granite and aplites, all these members being regarded as the various differentiation products of the same magma. The peridotite has been altered into serpentine, and it is in the latter rock that the veins of asbestos have been developed; these asbestos deposits are actively worked at

Thetford and at Black Lake, and the Province of Quebec supplies over eighty per cent. of the world's production of asbestos.

The deposits of chromite of Little Lake St. Francis are also found in a peridotite, partly serpentinized, near its contact with a diabase. This occurrence is very interesting to mineralogists for, in the granitic phases of the differentiated rocks which occur associated even with the ultra-basic rocks, the presence of various interesting mineral specimens is observed, such as vesuvianite, talc crystals, colourless garnets, etc. Dr. Palache, with the help of a six-pound sledge hammer, and an energy greatly admired by all, collected beautiful specimens.

The mode of occurrence of the asbestos, and the alteration of the olivine rock into serpentine, gave rise to very interesting discussions among the excursionists. This alteration, in a great measure, is a process of hydration of the olivine, which converts it into serpentine and chrysotile asbestos. The workings of some of the mines have reached a depth of 80 metres, and at that distance from the surface there is no change in either the nature of the rocks or the contents of asbestos. It would therefore seem that the asbestos owes its origin to a process which took place in depth, and in which the magmatic waters and vapours of the igneous rocks played a more important part as hydration agencies than the meteoric waters, although the latter may also have had some influence.

On the return trip, the excursionists stopped at Coleraine for an hour and a half to examine the contact breccia resulting from the action of the magma on the invaded country rocks. This breccia has been observed at several points on the periphery of the batholith.

After two hours stop at Sherbrooke, the train arrived in Montreal at eight o'clock in the evening and in Toronto on Thursday morning, August 7th, for the opening meeting of the Congress.

Excursion A. 7.

GEOLOGY OF THE MONTEREGIAN HILLS.

Leader:—F. D. Adams.

Guides:—J. A. Bancroft, Rev. Abbé Guimont, R. P. D. Graham.

Secretary:—S. W. Werner.

Members:—Arschinow, Russia; Backstrom, Sweden; Bascom, Miss, U.S.A.; Bergeat, Germany; Bœke, Germany; Cross, U.S.A.; Cushing, U.S.A.; Daly, R.A., U.S.A.; Daly, A.L., U.S.A.; Dinham, Great Britain; Evans, Great Britain; Geijer, Sweden; Gill, U.S.A.; Grabham, Sudan; Guinsberg, Russia; Harker, Great Britain; Horne, Great Britain; Howe, U.S.A.; Kemp, U.S.A.; Kozu, Japan; Lacroix, France; Lacroix, Mme., France; Lantenois, Indo-China; Leowinson-Lessing, F., Russia; Leowinson-Lessing, W., Russia; McRobert, Sir A., Great Britain; McRobert, Lady R., Great Britain; Michalon, France; Milch, Germany; Prindle, U.S.A.; Raisin, Miss, Great Britain; Stansfield, Canada; Steinmann, Germany; Stratanowitz, Russia; Szadecsky, Hungary; Termier, France; Termier, Mlle., France; Tschernyschew, Russia; Visconte, Russia; Wright, U.S.A.

The excursion was arranged in order that members of the Congress might see some of the chief features of the petrographical province of the Monteregian hills.

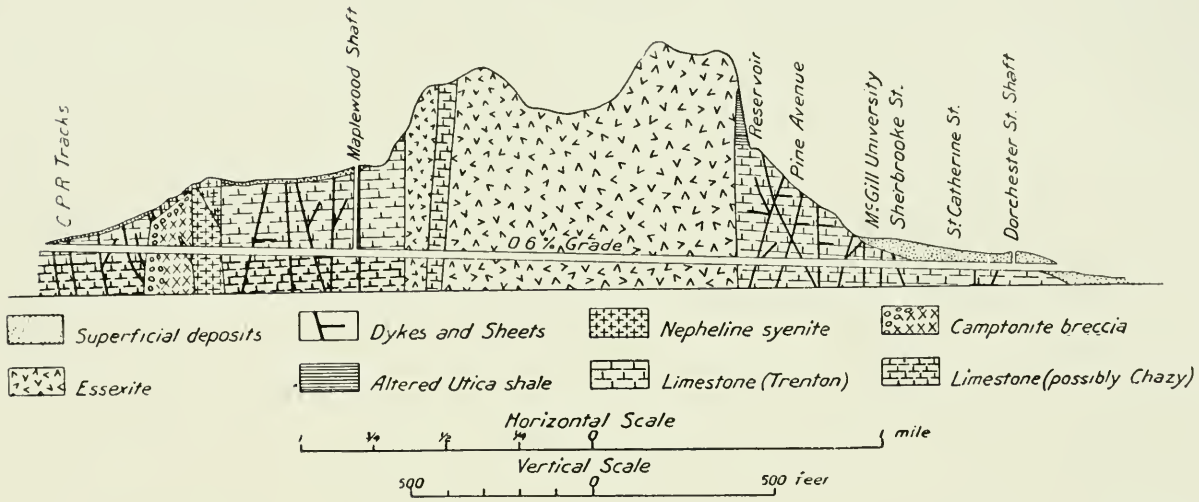
This province is remarkable in being sharply circumscribed and consists of eight hills or "mountains", with outlying dykes and sheets that break through the nearly horizontal Ordovician strata of the plain of Central Canada. The rocks are highly alkaline, belonging to the essexite-nepheline syenite succession, with a great development of the dyke rocks consanguineous to this series.

The party visited two of the mountains—Mount Royal and Mount Johnson—and the examination occupied two days. On the first day, Mount Royal was visited. In the morning, the party met at the Students' Union of McGill University, and walked through the southern campus, which is underlain by glacial drift, overlying Trenton limestone, to the Redpath museum, where maps of Mount Royal were exhibited, as well as a model showing the chemical composition of the rocks of this petrographical province.

The party then commenced the ascent of Mount Royal, making the first stop at the "Reservoir Extension," where the Trenton limestone, dipping at a very low angle to the south, is cut by a large number of dykes of camptonite, monchiquite, tinguaite, etc. From this point, the road ascended over the basset edges of beds of Trenton limestone, showing more or less alteration, to an exposure of highly altered Utica shale overlying the Trenton. Exposures of the essexite were examined near the "look-out," where the rock is coarse in grain and varies considerably in texture from place to place. Other large exposures of the essexite were seen north of the "look-out" where they display the characteristic weathering of that rock, and where dykes similar to those mentioned above cut the essexite itself. When the atmosphere is clear an excellent view can be had from the "look-out" over almost the entire area of the Monteregian Hills. Unfortunately, however, on the day of the excursion, the smoke from the city partly obscured the landscape, although the nearer portions of the plain traversed by the St. Lawrence, with the mountains of Montarville and Belœil, were well seen.

The party then continued through the Roman Catholic cemetery on Mount Royal, where the nepheline syenite breaks through the essexite and holds many angular inclusions of it. Descending the steep northern slope of the mountain, the party had an excellent view over the plain to the North, the escarpment marking the margin of the Canadian Shield standing out clearly on the horizon. At the foot of the slope, at the quarry known as Forsyth's or the Corporation quarry, the Trenton limestone was seen in contact with the nepheline syenite, which, here also, holds many fragments of the essexite, the whole complex being cut by a swarm of dykes. The limestone is intensely metamorphosed by the nepheline syenite, gradually losing its blue colour as the contact is approached and at the contact being altered to a coarse white marble. Dykes of camptonite (several varieties), tinguaite, monchiquite, nepheline syenite, aplite, etc., were examined. The nepheline syenite in this locality was, for many years, quarried for the purpose of obtaining road metal for the city streets of the city of Montreal.

An interesting occurrence of breccia at Mount Royal Heights was next examined. The breccia is formed by a sheet of camptonite breaking through a shattered series of beds of Trenton limestone.



Section through Mount-Royal along the line of the Canadian Northern Railway tunnel.

(From Guide Book No. 3, Int. Geol. Congress.)

The limestone fragments are thickly crowded together, and are seen to have been more or less altered by the heat of the enclosing camptonite. They are, in part, recrystallized, although in many of them the Trenton fossils can still be distinctly recognized. From this point, the party returned to Montreal in a special car, and took lunch together at the McGill Students' Union.

After lunch, the party went by motor cars to the quarries of Morrison & Co. and Rogers & Quirk, the eastern outskirts of the city. In them, an immense horizontal sheet of tinguaite is opened up and worked for road metal and for the manufacture of concrete. The rock is very fresh. It is rich in nosean, and also holds rinkite, lavenite, rosenbuschite and other rare minerals. At one point, the dyke which fed the sheet had been laid bare by the quarrying operations, and its relation to the sheet could thus be distinctly seen.

The party then crossed the city in their motor cars to the River St. Lawrence, where they took passage in a ferry to St. Helen's Island. Here the remarkable conglomerate or breccia which forms the greater part of the island was examined. The conglomerate was found to contain not only fragments of all the underlying stratified succession down to and including the Laurentian gneiss, but also large masses of highly fossiliferous limestone of Upper Silurian and Devonian ages, i.e., of strata much more recent than any which are now found in place in this part of Canada. The inclusions of this newer limestone have evidently sunk down into the magma from strata of Upper Silurian and Devonian ages, which at one time overlay the Ordovician succession there, but which have been since removed by erosion. The party then returned to Montreal, where they spent the night.

The next day was devoted to an excursion to Mount Johnson, another of the Monteregian hills, which rises from the plain 35 kilometres east-south-east of Montreal. A special train was taken at 9 a.m., which, leaving Bonaventure station of the Grand Trunk Railway, and crossing the St. Lawrence by the Jubilee bridge to St. Lambert, continued across the plain to the foot of Mount Johnson. This mountain is much smaller than Mount Royal and is elliptical in outline. It measures 1,066 by 761 metres at its base and is 267 metres high. It is a small but typical plug of igneous rock cutting vertically through a series of horizontal shales which

at the contact it alters to typical hornstones. The intrusive mass affords a most striking example of magmatic differentiation. The outer portion next to the hornstone collar is pulaskite—a rather coarse-grained, white alkali syenite, containing a little nepheline, and corresponding to the nepheline syenite of Mount Royal. The syenite forms a relatively narrow zone, and passes rather rapidly through a transitional rock into the essexite, which forms the mass of the mountain and which, towards the centre of the intrusion, becomes an olivine essexite.

Leaving the train at the foot of Mount Johnson, the party first examined the hornstone collar exposed in the maple wood about the base of the mountain. On the lower slopes large exposures of the typical pulaskite were found. Having examined these, the party climbed the very steep face of the hill, examining excellent exposures of the transitional rock before mentioned, to the typical olivine-free essexite, and thence to the summit of the mountain, where large glaciated surfaces of the somewhat finer grained olivine-bearing essexite of the central portion of the mass were found.

From the summit of Mount Johnson, a fine panoramic view was obtained over the adjacent portion of the great plain of central Canada. On the horizon, to the west, the Adirondack mountains could be seen in the State of New York. Between these and Mount Johnson, the Richelieu river could be traced from its source in Lake Champlain, northward by St. John's and Chambly, to its junction with the St. Lawrence. The other mountains of the Monteregian group, Mount Royal, Montarville or St. Bruno, Beloeil, Rougemont and Yamaska, were in full view, rising abruptly from the surface of the plain.

The party then descended the eastern slope of the mountain to large quarries in which essexite has been worked at this locality. Here lunch was served. In these quarries, evidences of the vertical upward movement of the essexite magma in the plug were excellently seen, the flow structure being clearly displayed on the great quarry walls.

Very few dykes are found in association with the intrusion at Mount Johnson, the mountain, in this way, differing in a striking manner from Mount Royal, on whose sides swarms of dykes are found almost everywhere. The most important dykes which occur on

Mount Johnson are those cutting the essexite at the quarry just mentioned. Of these, a large dyke of phonolite and one of a spheroidal tinguaite may be especially mentioned.

The party then continued their descent by the quarry road to the train and reached Montreal late in the afternoon.

Excursion A. 8.

MINERAL DEPOSITS OF THE OTTAWA DISTRICT.

Leader:—J. Stansfield. | **Secretary:—M. E. Wilson.**

Members—R. Beck, Germany; A. R. Crook, U.S.A.; H. S. de Schmid, Canada; T. Flores, Mexico; S. Foslie, Norway; A. C. Lane, U.S.A.; E. T. Mellor, South Africa; Sir H. A. Miers, England; P. P. Piatnizky, Russia; E. Poitevin, Canada; J. B. Porter, Canada; H. C. F. Schulze, Germany.

The excursion left Place Viger railway station, Montreal, at eight a.m., August 4th, for Buckingham. Lunch was served at the Alexandria Hotel, and immediately afterwards the party left in carriages for the Emerald mine. Typical Laurentian scenery was presented.

An interesting discussion at McGuire's pit, where the first halt was made, showed that conclusions as to the relative ages of the rocks reached at one point could be exactly reversed at a point only a few yards distant, thus emphasizing the difficulty attending field work in the district. The diorites cut by pegmatite veins and the richly garnetiferous gneisses near Emerald mine were next examined with a view to determining their possible sedimentary origin. At Murray pit, the mode of occurrence of the apatite, and the size and shape of the ore bodies were noted, the material on the dumps furnishing the best opportunity for collecting and studying the relations of the different minerals. On the southern hill, more garnetiferous gneisses and quartz-rich gneisses were seen in complex re-

lationships with pegmatites and diorites. A fine example of one of the diabase dykes of the region was pointed out just before leaving the hill.

The return journey to Buckingham was made by river steamer, the point of embarkation being only a stone's throw from the old wharf from which the apatite was shipped in former days. The many turns in the channel of the Lièvre River and the waning light of the summer evening gave a constant charm to the voyage. Buckingham was reached at 6.30 p.m., and the evening was spent in a leisurely tour round the saw and pulp-mill of Mr. MacLaren, that gentleman kindly throwing the mills open to our inspection and personally conducting us through them and explaining the various stages of the process.

Tuesday, August 5.

The party visited the Walker mine under the guidance of Mr. H. P. H. Brumell, who had charge of the mine during its most active development, and was consequently able to give much information as to the mode of occurrence of the graphite and the dimensions of the ore-bodies.

The exposures immediately to the north of the main pit showed the Grenville limestone highly metamorphosed and folded and carrying a band of graphite of one foot in width, the whole lying below a capping of massive gneiss which had no indications of folding. Between the two could be followed, with difficulty, the sheet of enstatite-gabbro previously described by Osann. The small pit, 600 feet north of the main pit, proved to be a point of considerable interest. Here a smooth nose of pegmatite was seen pitching steeply to the south at the northern end of the pit, whilst at the southern end gneisses with vertical banding occurred. The ore had been removed from the smooth surface of the pegmatite, and, in one place, the pegmatite had been broken through, revealing the gneiss below and showing that the pegmatite was little more than a foot in thickness. The most satisfactory explanation of the form of the pegmatite vein appeared to be that it had a shape similar to those of the saddle-reefs of Bendigo, having possibly been intruded along a previously formed anticline, the graphite ore being formed

at the upper surface only of the pegmatite. A part of the pegmatite was found to bear scapolite at a point where it cut limestone. The hill above the mill showed a typical occurrence of Grenville limestone and the igneous pre-Cambrian gneisses. The latter showed the intimate and difficultly decipherable relations that often obtain between different rock types in this district.

After lunch, an exposure of impure Grenville limestone was visited at the fall of Lièvre River. Occasional angular blocks of foreign material seen in the limestone were interpreted as the fractured remnants of dykes or tongues of igneous rocks which were ruptured at the time when the limestone became folded.

The Dominion mine was reached early in the afternoon. An examination of the country rock and ore-body at the main pit, so far as this was possible in the drowned state of the pit, showed that the ore was an impregnated pyroxenite, and that the graphite was associated with a gabbro, of which varieties ranging from anorthosite to pyroxenite were met with.

A very interesting section showing brecciated Grenville limestone and recrystallized sediments (cordierite-sillimanite-garnet-gneiss) was exposed at another small pit, where the ore-body evidently followed the dip of the beds, and no connexion with an igneous mass could be established.

By the courtesy of Mr. Brumell the party was conducted through the mill, where the "dry process" for extracting graphite is beautifully exemplified.

In the evening the party left Buckingham by train for Ottawa.

Wednesday, August 6th.

Proceeding by C.P.R. to Kirk's Ferry, the party crossed the Gatineau river by ferry and walked to the Nellis mine, stops being made on the way to examine the granite-gneisses and the impure Grenville limestones.

At the Nellis mine a vein had been uncovered at the surface to show the mode of occurrence and the methods adopted in prospecting. A shaft following the same vein to a depth of thirty feet enabled the party to study the variations in the vein, which were beautifully illustrated. At the south end of the hill the other

characteristics of the veins were observed, the general similarity of strike, the pinching out at the surface, the combs of pyroxene crystals on the vein walls and one of the two examples of a vein not following the general strike common to the hill. Other veins were examined that further illustrated the mode of occurrence of the mica and its relation to other vein minerals.

After lunch the chute on Gatineau River was visited and the return trip was made by train from Kirk's Ferry to Ottawa. Leaving Ottawa at 10.45 p.m. the party arrived in Toronto at 7 a.m. on Thursday, August 7th.

Excursion A. 10.

PLEISTOCENE—MONTREAL, COVEY HILL AND OTTAWA.

The party consisted of seventeen members, as follows:—Barrell, J., United States; Cole, L. H., Canada; Dupaigne, Rev. P., Canada; Goldthwait, J. W., United States; Johnston, W. A., Canada; Keele J., Canada; Kummel, H.B., United States; Lachmann, R., Germany; Lamothe, L. de, France; Leverett, F., United States; Lory, P., France; Paredes, T., Mexico; Powers, S., United States; Romer, E., Austria; Urbina, Mexico; Wolff, T. F. W., Germany; Woodworth, J. B., United States.

The greater part of the first day, Monday, August 4th, was spent in Montreal. Leaving the local headquarters of the Congress at 9 o'clock, the party entered Mount Royal Park by way of the Côte des Neiges Road. Just outside the gate, attention was drawn to a section which showed very poorly stratified, stony marine beds resting on a rather steeply sloping rocky surface—an illustration of sea margin deposit where the waves have little opportunity to build actual beaches. Proceeding next to the gravelly slope near the foot of the park slide, the members stopped to study pits or beaches, which partially enclosed a shallow lagoon at a time when the sea stood near the 570-foot contour. Through the courtesy of Mr. Henderson, the park ranger, the party was enabled to collect shells

of *Saxicava rugosa* (*arctica*) from a freshly excavated ditch in the highest of these beaches. The delicate form of these spits as compared with great sea-cliffs and terraces of extinct shore-lines in other regions caused comment, but their littoral origin was not questioned. It was pointed out that the land must have been rising rapidly from the sea at this stage of submergence, inasmuch as the spits are short and their bulk small, although the conditions of slope and supply of beach material from adjacent cliffs were favorable for rapid beach construction.

Going on along the park drive past the ranger's house to the corner, and taking the turn towards the west, the party found a freshly dug trench beside the road in which well worn gravels were to be seen on the surface up to 600 feet above sea level. These had not been seen by any member of the party until the day before the excursions. The possibility of their marine origin was admitted, but regarded as doubtful for two reasons: (1) deeply decomposed rock in a quarry at the rear of the Mount Royal cemetery, near by, shows no sign of washing on the surface, where waves should have left their mark, at an altitude of scarcely 600 feet; and (2) the gravels above the level of the 570-foot beach, so far as observed, do not display typical wave-built form. At the corner of the park roads already mentioned, however, notice was called to a short, smooth-topped ridge of gravel which connects the main eminence of the mountain with a 665-foot hill in such a way as to suggest a land-tied island, with the gravel bar standing at about 625 feet. Some members of the party were inclined to accept this as a marine form, although they recognized the probability that local deposits of gravel took place just before the actual entrance to the sea, in irregular pools along the thinning edge of the ice-sheet, where wave action was impossible.

On the way back to the city, the party visited the Peter Redpath Museum, where Mr. Ardley, the curator, showed them Sir William Dawson's unrivalled collection of post-Pleistocene shells and skeletons of the St. Lawrence valley. Lunch was eaten at the Edinburgh Cafe. Immediately after lunch, a number of the members went by street-car to the Papineau Avenue quarries, where they saw a section of *Saxicava* gravels and boulder clay overlying a striated surface of Trenton limestone.

Late in the afternoon, the entire party left by regular train for Hemmingford, where they found lodgings at Orr's Hotel. In the evening, the members were welcomed by the people of the village at an outdoor social on the lawn beside the Episcopal Church. Mr. Robb, member of Parliament from the district, and ministers of the local churches, spoke words of greeting and good will. For the visiting party, Prof. Woodworth responded, explaining the purposes of the party in coming to Covey Hill.

On Tuesday, the party set out, after breakfast, in wagons for Covey Hill, ten miles away. A short stop was made at a gravel pit just south of the village, in order that the visitors might collect *Saxicava* shells. A few valves of *Macoma Greenlandica* were found, also, at a roadside post hole near frontier settlement. Arriving at the Covey Hill Methodist Church, all left the wagons, in order to set foot on the fine beaches of sandstone slabs which cross the road at that point. The distant view northward across the St. Lawrence lowland, from here, included the island-mountains of the Monteregian group, and served well to carry the observations of the preceding day over to those of the day at Covey Hill. The extraordinary strength of these beaches, in contrast to their counterparts on Mount Royal, was regarded as a result of the kind of material available rather than to heavier surf or a longer stand of the sea at the more southerly locality.

At Covey Hill corners, a short walk down the road northward to a gravel pit on Mr. Cole's property served to show the party that the beach ridges so plainly developed below 525 feet terminate abruptly at that height. Shallow cuts in the ground and post holes by the roadside showed still with no covering of wave-washed material on the slope above the 525-foot beach, and rolled gravels everywhere below it. The conclusive character of this evidence was accepted by all present. Later, while continuing the ascent of Covey Hill, the members looked for signs of wave work at higher levels, but saw none.

Luncheon was served to the party by the ladies of Covey Hill in a pretty grove near the Sutton place. The Hon. Mr. Robb and other guests were present. A tour of the famous "Gulf" and gorge occupied most of the afternoon. Entering the valley of the ancient outlet of glacial Lake Iroquois near its head, at the "upper lake,"

the party visited the cliff which is thought to mark the site of an extinct Niagara. The narrowness of the gorge at this point caused some discussion of the merits of the theory that it lay along the course of a river which carried the entire discharge of the great Lake Iroquois; and to account for it, a possible line of auxiliary drainage beneath the ice around the North side of Covey Hill was suggested. Prof. Woodworth acted as guide on this part of the excursion. At the Gulf, opportunity was given to descend the side wall of the gorge and thus secure a view of it from the floor below. Two of the members, Messrs. Leverett and Goldthwait, made a cross traverse of the old outlet floor, with an aneroid barometer, in the vicinity of the Gulf, in order to see how wide and deep the channel might have been. In the width of over a quarter of a mile, the depth of this channel seems to have been less than twenty feet, except possibly at that place where the present gorge occurs.

Upon returning to Covey Hill Corners, at five o'clock, the members of the party were the guests of Mr. L. H. Cole and his mother at afternoon tea, on the lawn beside the Cole cottage. The ten-mile ride to Hemmingford was completed in time for a late supper at the hotel.

On the return to Montreal, early Wednesday morning, the party was reorganized into two divisions. One, consisting of Messrs. Leverett, Lachmann, Paredes, Urbina, Wolff, Cole and Johnston, proceeded to Ottawa; the other, including Messrs. Dupaigne, Goldthwait, Keele, Kummel, De Lamothe, Powers, Romer and Woodworth, went to Rigaud Mountain. Messrs. Barrel and Lory remained at Montreal. Those who spent the afternoon in Ottawa gave special attention to the ridges of coarse bouldery drift in Hull, the origin of which has been disputed. Messrs. Leverett and Wolff, as spokesmen for the party, reported that they were inclined to the opinion of Chalmers that these ridges are not moraines, but deposits from floating ice coming down the Ottawa and Gatineau rivers during the period when the valley was emerging from the sea. This view is important in that it makes it unnecessary to suppose that the ice sheet re-advanced at Hull after the underlying marine clays of the Champlain stage had been deposited. The party which went to Rigaud Mountain spent the day inspecting the boulder beaches at the Devil's Garden, mentioned by Dawson in the *Geology of*

Canada, p. 896. From near the top of the mountain, about 600 feet above the sea, down almost to the level of the shrine, at 450 feet, the slope is covered with rolled boulders to a depth of at least 10 feet over several hundred acres. Twenty or thirty distinct ridges with even crestlines and forward slopes of characteristic form indicate that the boulders were arranged by the waves during the period when this mountain was an island in the sea. Descending from the uppermost ridges towards the lowest ones, one sees a steadily decreasing size and increasing roundness of the boulders. Although no marine shells have been found in the deposit, the occurrence of the beaches up to but not above the 600-foot contour, confirms the view that they, like those on Mount Royal, are marine. The bouldery structure of the Rigaud beaches, so astonishing to one who has just visited the weak sand spits of Mount Royal, illustrate how the character of available material determines the topographic strength of beaches.

The two divisions of the party came together again on Wednesday evening at supper in the Hotel Russell at Ottawa, and proceeded, by night train, to the assembly of the Congress at Toronto.

Excursion A. 11.

ORDOVICIAN OF MONTREAL AND OTTAWA.

Leader:—Percy E. Raymond **Secretary:—Elfric Drew Ingall**

The following members took part in the excursion:—

Gordon, United States; Gregory, United States; Heine, United States; Holtedahl, Norway; Hume, Egypt; Ingall, Canada; Miller, United States; Nicholas, Great Britain; Raymond, United States; Schuchert, United States; Stille, Germany; Ulrich, United States.

The party assembled at the Place Viger Station in Montreal on Monday morning, August 4th, and proceeded by train to St. Martin

Junction, where the extensive limestone quarries in the Chazy were visited. From the quarries the party walked to the railroad cutting at Park Laval. At both localities considerable numbers of fossils were obtained, particularly the spherical cystid, *Malocystites murchisoni*. At the quarries the members of the party were especially interested in the strata which were almost entirely made up of cystid remains.

In the afternoon the party divided, one division visiting St. Helen's Island and the other going to the exposures of the lower Trenton in the quarries at Mile End. There was considerable discussion as to the exact ages of the various "Lowville," "Black River" and "Trenton" formations exposed at the latter place, but no definite conclusions reached. In the evening the party proceeded to Ottawa.

Tuesday morning was devoted to the exposures of the Trenton in Hull and Ottawa, and Drs. Stille and Holtedahl were especially interested in the cherts of the lower (Crinoid) division of the Trenton. The cherts occur as thin nodules or plates parallel to the bedding, and it was brought out that the bedding planes could also be distinguished in the cherts themselves. The members were also interested in the contorted and unevenly bedded strata of the cherty layers and the immense boulder beds which formed the overburden of the quarries. Many fossils were obtained from the "*Prosopora*" beds near their contact with the "*Tetradium*" beds at the axe factory in Hull.

In the afternoon the exposures of Utica and Collingwood strata near Cummings Bridge were visited and many fossils secured, largely through the instrumentality of Mr. J. E. Narraway of the local committee, who acted as guide, and who turned up many specimens of *Triarthrus spinosus*. From Cummings Bridge the party proceeded to Division Street to see the Upper Trenton or Picton beds, and were fortunate in finding very good specimens of *Strophomena trilobata*, showing the interiors of the valves. This species is rare about Ottawa. It may be noted in passing that this may be the last international party which will be able to collect at this old quarry, which is well known among palaeontologists, for two buildings had been erected within its limits between the time of the writing of the guide book and the visit of the party, and the entire ground will probably soon be covered.

Wednesday morning was spent at the Victoria Memorial Museum, where Mr. Lawrence M. Lambe and Mr. W. J. Wilson very kindly assisted in explaining the collections. A photograph was made of the party grouped around the Logan Memorial.

In the afternoon the party again divided into two sections, one taking a general view of the region by visiting Britannia and Rockcliffe, and the other going to Mechanicsville to collect fossils from the Lowville and Leray.

In the evening the party left for Toronto.

GEOLOGY OF QUEBEC AND VICINITY.*

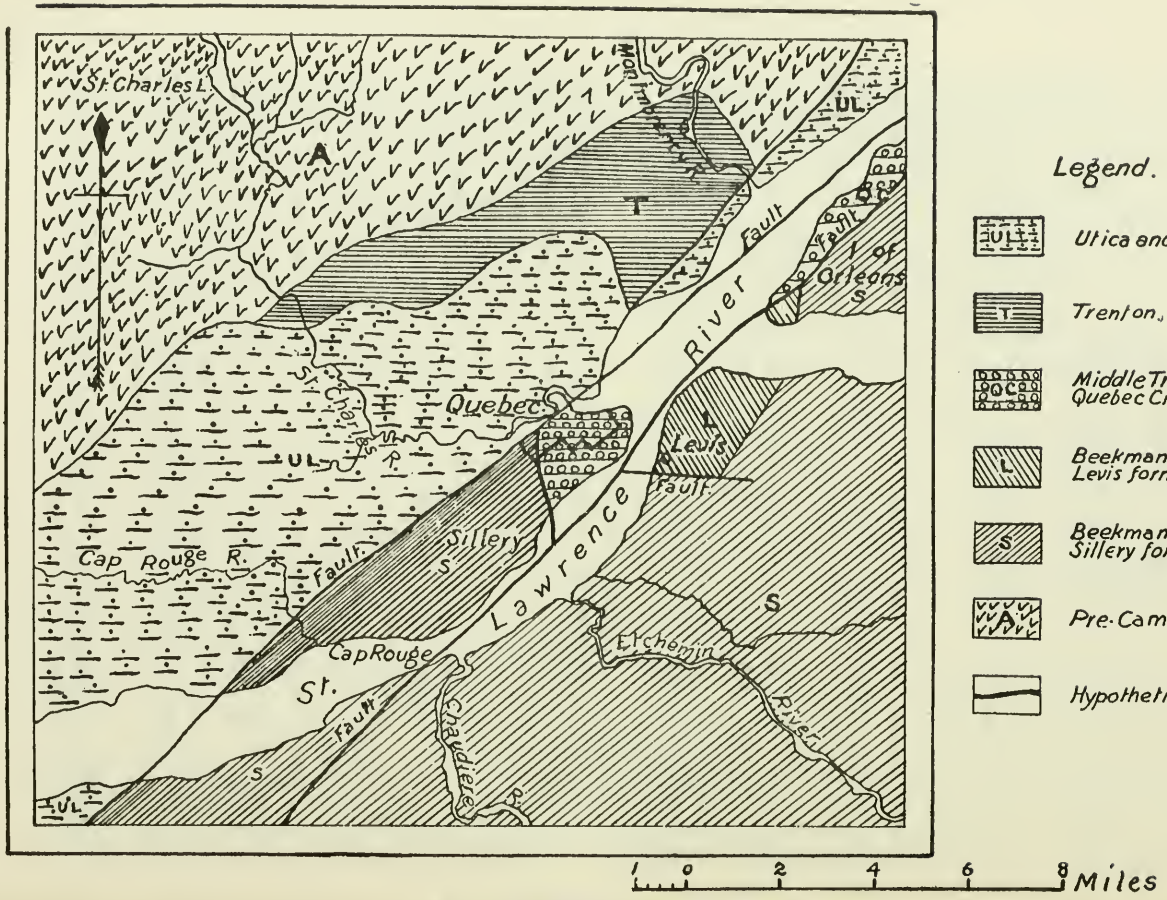
(Percy E. Raymond.)

INTRODUCTION.

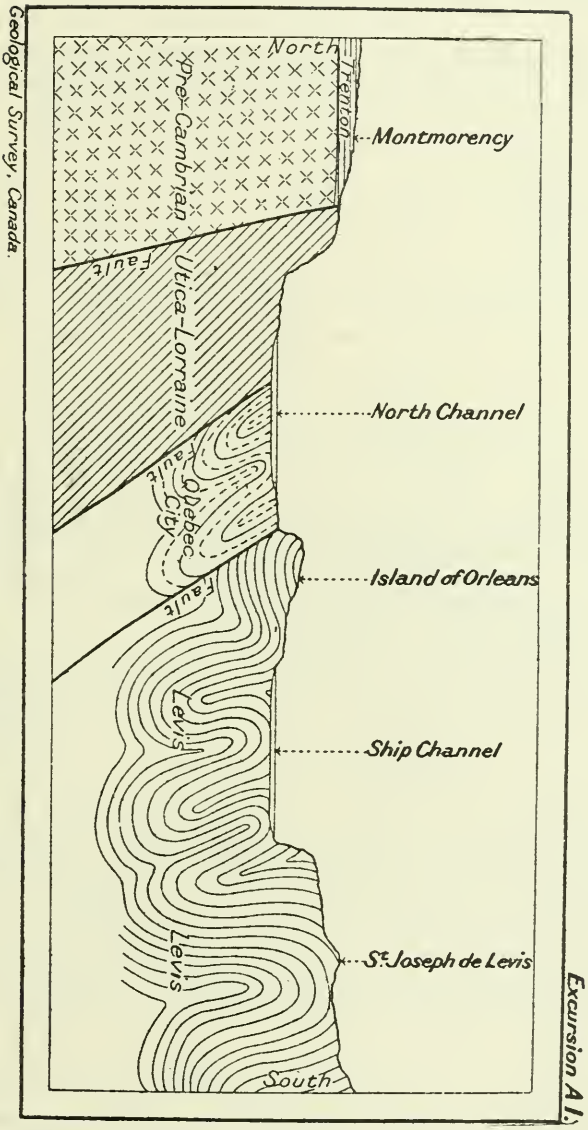
The beetling cliffs which make Quebec the "Gibraltar of America" have been a puzzle to geologists since the earliest days of the science in America. The "Quebec group," involved, as it became, with the "Taconic" controversy and the "Theory of colonies," was for many years the subject of hot and world-wide discussion. Such noted men as Lyell, Bigsby, Logan, Billings, Marcou, Selwyn and Hunt have repeatedly clambered over these rocks, and given to the world the most diverse views as to their age and relative positions. Barrande took a part in the wordy war, and Lapworth furnished one of the most important clues for unravelling the tangle. Although there is still much to be learned, the discovery of fossils and a closer study of the structure have elucidated the main features of the region. To this more recent work, Walcott, Ells, Weston and Ami have been the main contributors.

The City of Quebec lies principally upon a narrow and high promontory on the north side of the St. Lawrence. To the north of the city is a broad valley, now occupied by the St. Charles river, but which was, at no very ancient date, the main valley of the St. Lawrence. Quebec city thus occupies the eastern point of a long narrow ridge, the western edge of which is at Cape Rouge, 8 miles above the city. To the south of this ridge is the narrow gorge now occupied by the St. Lawrence, and to the north the broad valley occupied in part of the St. Charles. North and east of the latter valley is the pre-Cambrian highland, bordered by a narrow belt of Ordovician sediments. South of the St. Lawrence rise the steep cliffs of Levis. The sediments north of the St. Charles rest upon the pre-Cambrian, and the oldest are of Trenton (Middle Ordovician) and the newest of Lorraine age (Upper Ordovician). The promontory on which Quebec city is built consists of shale and limestone

*Extract from Guide Book No. 1—International Geological Congress, XIIth Session, Canada 1913.



Geological Sketch Map of Quebec and Vicinity.



Generalized section across St. Lawrence Valley.—See page 114.

of Middle Trenton age, and the strata on the south side of the river are of Beekmantown age (Lower Ordovician).

The prevailing strike of all the beds is northeast-southwest, magnetic, and the strata are thrown into tightly folded, overturned anticlines and synclines with steep dips to the southeast. There are three major faults approximately parallel to the strike, two of them thrust faults with a heavy throw to the northwest, and one normal fault with a drop to the southeast. The first of the thrust faults occupies the bed of the St. Lawrence between Quebec and Lévis, but is seen along the northern side of Orléans island, where the Lévis formation is thrust upon the Quebec city formation. The second fault passes from above Cape Rouge on the St. Lawrence along the northern side of the ridge on which the city is situated and thence along the valley of the St. Charles into the St. Lawrence, where it passes between Orléans island and the north shore at Montmorency. By this fault the Quebec City formation is thrust over the Sillery and Lorraine. The third fault is well shown at Montmorency, where, by a drop of about 600 feet (180 m.) the Lorraine is brought down to abut against the pre-Cambrian.

The main structure and the faults are shown in the accompanying generalized section across the valley.

In the absence of any detailed knowledge, the amount of lateral movement involved in the thrusts can only be conjectured. It must be very great, however, for the Sillery, Lévis and Quebec city formations do not belong to the same province of deposition as the Trenton, Utica, and Lorraine. In the region north of the St. Lawrence the Trenton rests upon the pre-Cambrian with sponges and corals adhering to the gneiss in the position in which they grew, thus showing that the contact is not due to a fault. Yet, only a mile away, on the Island of Orléans, is a great thickness of older (Lower Ordovician) rocks. Logan explained this by assuming a very great steepness for the shore line here, so that the gneiss of Montmorency was not submerged till Trenton time, but now that we know that both the Quebec city formation and the limestone at Montmorency are of Trenton age, though with hardly a fossil in common, it becomes impossible to accept this explanation. In New York State, the strata containing the same fauna as the Quebec city rocks, lie nearly 50 miles (80 km.) east of the nearest outcrop

of strata containing the typical Trenton fauna, but the thrust need not necessarily have been so much as that.

The following formations, amongst others, occur in the vicinity of Lévis, Quebec and Montmorency.

		At Quebec and Lévis.	*At Montmorency.*
Ordovician	Upper		Lorraine.
			Utica.
	Middle	Quebec City.	Trenton.
	Lower	Lévis.	
		Sillery.	

LORRAINE (FRANKFORT) FORMATION.

The Lorraine in this vicinity is a fine, soft, grey shale, with thin layers (1 to 3 inches in thickness) of sandstone. There are occasional thicker layers of sand or limestone conglomerate. The thickness is at least 700 feet (215 m.), with the top not seen. Fossils, other than a single species of graptolite, *Diplograptus pristis*, are not common, but a few species, *Triarthrus becki*, *Cryptolithus tessellatus*, *Plectambonites sericeus* and *Dalmanella testudinaria*, have been found.

UTICA FORMATION.

The Utica is a much darker and less micaceous shale than the Lorraine, and contains, besides *Triarthrus becki* and *Leptobolus insignis*, a considerable variety of graptolites, *Climacograptus typicalis* and *Climacograptus bicornis* being the more common. At the base is a small thickness of impure, blocky limestone containing the same fauna, with the addition of a few survivors from the Trenton. The total thickness of the Utica is about 200 feet (60 m.)

TRENTON FORMATION.

The Trenton consists of thin-bedded, dark blue limestone with shaly partings. It is extensively quarried, and used for all purposes, from building stone to road metal.

The Trenton here may be divided, on the basis of fossils, into four zones, all of which can be traced from Quebec to Central New York and some of which are recognizable as far west as Minnesota. The fossils characteristic of the upper zone are *Prasopora simulatrix* and *Dinorthis meedsi*. The principal fossils of the next lower zone are *Cryptolithus tessellatus* and *Triplecia nuclea*, while in the zone below is the nautiloid, *Trocholites canadensis*. Finally, at the base, are a few feet of strata with *Parastrophia hemiplicata*. The first fauna occupies the upper four-fifths of the formation, and the last three the lower fifth. The total thickness is about 500 feet (150 m.)

QUEBEC CITY FORMATION.

The Quebec city formation consists of hard, fine-grained limestone, very dark shale, and thick and thin beds of limestone conglomerate. The shales are frequently more or less altered and show secondary cleavage, but sometimes contain rather well preserved graptolites, among them such forms as *Corynoides calycularis*, *Climacograptus bicornis*, and *Cryptograptus tricornis*, fossils which are indicative of a mid-Trenton age. A few fossils other than graptolites have been found, but they are small shells, of no value in correlation.

The pebbles in the conglomerate are quite fossiliferous and contain such fossils as *Plectambonites pisum*, *Tretaspis diademata*, *Lonchodomas hastatus* and *Nidulites*, all unknown in the typical Trenton. Strata containing these fossils are now known to occur in eastern Pennsylvania and Virginia, where they are found in that part of the Ordovician section which elsewhere is usually occupied by the Black River and Lower Trenton. The thickness of the Quebec city formation is unknown.

LEVIS FORMATION.

The Lévis formation consists mostly of hard, grey, green, and red shale, thin-bedded hard, blue and light grey limestone, and thick and thin beds of limestone conglomerate. Neither the top nor bottom of the formation is known. About 1,000 feet (300 m.) of strata are exposed in the vicinity of Lévis. The shales contain a

graptolite fauna, the more prominent species being *Phyllograptus typus* and *Tetragraptus quadribranchiatus*. The limestones contain *Shumardia granulosa*, *Phyllograptus*, and *Dictyonema*. The Lévis is thus to be correlated with similar deposits low in the Ordovician of Europe.

Very fossiliferous pebbles have been found in the conglomerates in the Lévis, and the fossils show them to be derived from strata of three geological ages. The pebbles are: 1st, Lower Cambrian limestone with *Olenellus*, *Salterella*, etc.; 2nd, Upper Cambrian or Lower Ordovician ("Tremadoc" or "Ozarkian"), with *Symphysurus*, *Dikelocephalus*, etc.; 3rd, Beekmantown, with *Lloydia saffordi*, *Camarella calcifera*, and a great variety of brachiopods and cephalopods. Besides the limestone pebbles there are many of igneous rocks and quartzites, but they do not form nearly so large a proportion of the conglomerate as do those composed of limestone. The conglomerates also contain pebbles of the red and green shale and sandstone of the Sillery, thus proving that the Sillery is older than the Lévis, while the presence of Beekmantown fossils in both pebbles and matrix of the conglomerates show that the Lévis is of the same age as the Beekmantown at Philipsburg, Quebec. There are no outcrops of limestone containing the *Olenellus* fauna nearer than Labrador, 500 miles (800 km.) northeast of Lévis; the nearest outcrop of limestone containing the *Dikelocephalus* fauna is at Whitehall, N.Y., 250 miles (400 km.) southwest; and the nearest outcrop of fossiliferous Beekmantown is at Bedford, Que., 150 miles (240 km.) southwest of Lévis. Yet the vast numbers and often large size of the pebbles in the conglomerates indicate that the older limestones outcropped near the basin where the Lévis shales were formed, and it seems very probable that such beds now exist somewhere to the southeast of Lévis, entirely buried by the shales which have been thrust over them.

SILLERY FORMATION.

The Sillery is the oldest sedimentary formation now seen in the district, and very little of it is known. It consists of red and green shales, and lenticular masses of red and green sandstone. Like the Lévis it is thrown into tightly compressed over-turned folds, and contains so few hard beds that it is practically impossible to work

out its detailed structure. With the exception of the little inarticulate brachiopods, *Linarssonia pretiosa*, fossils are almost entirely lacking. The few that have been found, species of *Phyllograptus* and other graptolites, indicate a close similarity to the fauna of the Lévis. The Sillery also contains layers of limestone conglomerate, but the pebbles differ from the conglomerates in the Lévis in containing Lower Cambrian fossils almost exclusively, although an occasional specimen has been found which indicates the *Dikelocephalus* fauna. The thickness of the Sillery is unknown.

HISTORICAL NOTE.

The earliest account of the rocks in the vicinity of Quebec and Point Lévis is in a paper published in 1827 by Dr. J. Bigsby. Bigsby divided the rocks into three series, the gneiss, shell-bearing limestone, and a slaty series with conglomerate, and decided that the sedimentaries belonged to the Carboniferous series. Logan in 1843 thought that the strata of Lévis were below the limestone north of the St. Lawrence, but finally adopted the view that they were above, and thus the equivalents of the Hudson river and Lorraine of New York State. In 1885, Logan believed the Sillery to be the youngest of the formations present, and correlated it with the Upper Silurian "Shawangunk or Oneida conglomerate" of New York.

In 1857, James Hall reported on the graptolites of Point Lévis, and referred the shales containing them to the Hudson River group. Billings then took up the study of the fossils found in the conglomerates at Point Lévis, and Logan announced in 1860 that Billings had identified these fossils as of Chazy and Calciferous (Beekmantown) age, and that, therefore, the Lévis strata belong at the base of the Lower Silurian. In this paper the term Quebec group was first used and the course of the Champlain-St. Lawrence fault outlined. Marcou, in 1862, took exception to the views of Logan, and correlated the strata at Point Lévis with the Georgia shales (Lower Cambrian) of Vermont. Marcou explained the appearance of younger fossils in the conglomerates on the basis of Barrande's doctrine of colonies.

Billings, replying to Marcou in 1863, paralleled the strata of the fossiliferous part of the Quebec group with those of the Llandeilo of England and Australia, and the Calciferous and Chazy of America.

In the Geology of Canada, 1863, Logan described the Quebec group in great detail, tracing it from the well known exposures at Point Lévis both east and southwest, where it was supposed to have been altered into a complex series of crystallines. He still believed the Sillery to be above the Lévis, "provided the series was not inverted." He gives a map showing the structure at Point Lévis, and divides the Lévis into 17 zones, with a total thickness of 5,025 feet (1530 m.) The thickness of the Sillery was estimated at 2,000 feet (600 m.)

A comparison of the sections in Canada and Newfoundland led Billings in 1865 to the opinion that the shales at Point Lévis were at least 2,000 feet (600 m.) above the Calciferous (Beekmantown).

Lapworth in 1886, identified a number of collections of graptolites made by T. C. Weston, and correlated the fauna found at Point Lévis with that found in the Arenig of England. He also studied the graptolite fauna which had been collected in the City of Quebec, and stated that their age was probably Black River or Lower Trenton. The above correlations have since that time been universally adopted.

Ells, in 1888, gave an excellent summary of all work up to that time, a detailed description of the various formations in this region, and many new lists of fossils, the latter determined by H. M. Ami.

A POSSIBLE EXPLANATION OF THE GEOLOGICAL STRUCTURE.

The prevailing strike of all the sedimentary rocks in this area being NE–SW, and the dips generally to the SE, it was at first supposed that the strata formed a regular ascending series from the gneiss at Montmorency to the supposed Upper Silurian red shales of the Sillery south of the St. Lawrence. The discovery of fossils, however, showed this view to be incorrect, and each subsequent

collection of fossils has shown the structure to be more complicated than it had previously appeared.

From our present knowledge of the distribution of the faunas it would seem that at Montmorency we are near the southern margin of a great area of Trenton rocks which once extended far over the Laurentian highlands to the north. Infaulted remnants of such an expanse of limestone occur at Lake St. John, 200 miles (320 km.) northeast of Quebec, and at various other places north of the St. Lawrence. This limestone does not seem to have extended to any great distance south of the St. Lawrence, and during Trenton time there was probably a barrier here, to the south of which was a sea containing the Atlantic facies of the Trenton fauna (Quebec City formation). South of this barrier Lower and Upper Cambrian, Sillery and Lévis strata had also been deposited, but after Trenton time the barrier may have been submerged, so that Lorraine and Richmond shales may have been deposited over both the Trenton and the Quebec City formations.

It is generally conceded that the pressure which accompanied the Appalachian mountain building was exerted largely from the ocean side, and hence all overturning and thrusting at Quebec would be expected to be, as it is, from the southeast. It would seem that when the force was exerted against the great mass of Cambrian and Lower Ordovician strata which had accumulated south of the St. Lawrence, the Lower and Upper Cambrian limestones remained anchored, while the soft Sillery shales allowed the development of a thrust plane within their mass, so that a great thickness of Sillery, Lévis and Quebec City rocks was pushed toward the northeast from their original position. The drag at the bottom of such a thrust-block would tend to delay the anterior end, thus swelling the strata into an anticline. The front of this block, on reaching the scarps of the normal faults which had developed in this region would be stopped, and the anticline completely overturned and secondary thrust planes developed, so that the lower strata in the block would be thrust over the higher ones. If the greater part of such an overturned and fractured anticline were eroded away, the resulting arrangement of the formations would be such as is shown on the accompanying geological map of the Quebec area. This would account for the fact that the oldest strata, the Sillery, really appear highest in the section, and also for the

non-appearance of the Cambrian strata from which the boulders in the Sillery and Lévis were derived. It would also explain the fact that the Sillery and Lévis are much more crumpled and folded than the Quebec City, the latter formation being higher in the block, and so less exposed to friction during transport. It would still further account for the fact that the Quebec City and Lévis are exposed only in narrow bands close to the river, whereas the Sillery forms the greater areas to the south.

DETAILED DESCRIPTION

LEVIS: THE SHALES AND CONGLOMERATES OF THE LEVIS AND SILLERY FORMATIONS.

The high bluff on the south side of Main street, Lévis, which runs in a southwest direction from the neighbourhood of the Intercolonial Railway station, is composed of shale, limestone and limestone conglomerate of the Lévis formation. The Lévis formation continues until the turn at Point Lévis is reached, and beyond that point one sees only red and green shale and sandstone of the Sillery.

Along the roadside at Hadlow, there is a cutting in one of the sandstone beds of the Sillery. At this point the sandstone is so folded upon itself as to give the impression of considerable thickness. A few rods back, however, in a ravine which cuts across the cliff, the same sandstone is seen to have a thickness of only about 10 feet (3 m.).

A few rods farther to the southeast, just beyond the ravine, the red and green shales of the Sillery formation are exposed.

From this general neighbourhood an uninterrupted view is obtainable of the bluff on the northern or Quebec side of the river. The structures and formations displayed in this bluff are of great geological interest. The church on the bluff up the river and to the left is at Sillery, the town which has given name to the formation. The red colour of the bluffs at Sillery point can be seen, and the red shale bluffs extend down to the wooded cover which is almost opposite Hadlow. This wooded cove was the landing place of

Wolfe's army, and bears his name. There is a fault at Wolfe's Cove, and the cliffs from that point to the citadel are composed of hard shales and limestone of the Quebec City formation. The prominent building across the river, on top of the bluff, is the city gaol. To the left of the gaol are the Plains of Abraham, the battle field of 1759. About half way between the gaol and the Citadel is the drill hall in the Cove Fields, and it was the excavation for the foundations of the drill hall which furnished the well-preserved graptolites from which the Middle Trenton age of the Quebec City formation was determined. The prominent cliff in line with this building is Cape Diamond, and the rocks of the Cape and east of it are much more massive than those to the west. They are almost devoid of fossils.

At the exposures of the Sillery, on the Lévis side, just northeast of the ravine at Hadlow, the lower part of the cliff is seen to be made up of a bright red shale with green spots and streaks, while the upper part of the bluff is composed of green shale. In fragments of both red and green shale on the talus at the foot of the cliff, specimens of the only common Sillery fossil, *Linarssonia pretiosa* (Billings) may be found.

From this place as far northeast as Point Lévis red shale and thin sandy beds form the cliff on the southeast.

At Point Lévis, it may be noticed that the red and green shales extend as far as a small ravine close to the street car switch, and that harder grey shales are then encountered. Around the corner, behind the last house of the row to the right are grey shales with occasional bands of red, but beyond this point there is nothing but hard grey shale and limestone. The first impression received is that the Sillery lies above the grey shales, which belong to the Lévis, and that there is a gradation between the two indicated by the alternation of red and grey beds. A closer study of the cliffs, and the distribution of the beds on the flat at the top of the cliffs, shows that there is here in reality a marked change along the strike, and that there must be a fault separating the Lévis from the Sillery. There is, in fact, a small slip to be seen back of the easternmost house, and there is evidence of disturbance in the little ravine already referred to.

From Point Lévis to the foot of Davidson street, many folds in the limestone are visible in the cliff along Main street.

On the eastern side of Davidson street some distance above Main street and just below the bend in the road, a cutting has revealed the arch of an overturned anticline. The strata here are thin-bedded limestone and shale. The limestone contains *Dictyonema*, *Shumardia* and other fossils, and is locally known as the Shumardia limestone. The overturned condition of the strata is well shown here, the dip being uniformly southeast at an angle of 50° except for a short distance at the centre of the arch. The squeezing out of certain beds, particularly a thick shale, is also shown here.

Up the hill, thick beds of limestone are visible back of the little corner house, and between the beds of limestone are layers of shale with *Tetragraptus* and other graptolites.

Continuing up Davidson street to Côte du Passage, across that street and a short distance up a lane, one comes upon a heavy bed of limestone conglomerate with red and green shales on either side. As practically all the measures between this conglomerate and the centre of the anticline are exposed, and as there is no change of dip, it is evident that the conglomerate is above the Shumardia limestone. About 175 feet (53.3 m.) of shale and limestone intervene between the two.

If this conglomerate, which may be called conglomerate A, is followed eastward to the next street, it will be seen a short distance up the road from the top of the ruined elevator, and at the corner of the street above is a poor exposure of another conglomerate, marked B on the accompanying map. Descending the hill from Côte du Passage the same shales and limestones noted above the anticline are again observable in rock cuts. The centre of the anticline lies at the bend in the road, and the beds encountered below are a repetition of those above. The thick beds of grey limestone at the foot of the elevator should be noted and compared with those exposed in the cutting at the top of the hill.

From the foot of Côte du passage and Davidson street, northeastward along Main street, two bands of the thin-bedded Shumardia limestone can be seen extending along the face of the bluff to the wooden steps. Here the limestones disappear below the street level, and the axis of the anticline passes to the river side of the road. Between the next two buildings on the southeast, 500 feet (150 m.)

east of the steps a fault brings conglomerate A down nearly to the bottom of the cliff, and conglomerate B to the top of the bluff face.

The B conglomerate here is mostly thin-bedded limestone, with a little conglomerate at top and bottom. At the small point just beyond these two houses another fault brings conglomerate A down to the foot of the cliff, and B down against A. Immediately on the point are two other minor slips.

Beyond this point, are the best exposures in the vicinity of Lévis. Conglomerate A, which is 15 feet (4.5 m.) thick at the point where the faults occur, can be traced past the lime kiln at the foot of the bluff, up into the bluff face, where it dwindles to a mere two-foot bed. Above it is a conspicuous layer of thin-bedded limestone, and still higher the thin-bedded limestone of conglomerate B. The latter bed is here quite fossiliferous and contains *Phyllograptus anna, Dictyonema, Shumardia granulosa, Lingula quebecensis* and other fossils. In the middle of the cliff, below conglomerate A, is more thin-bedded limestone, and the fossils prove it to be the Shumardia limestone, here freed from the effect of the anticline and without the thick beds of grey limestone that are above it on Davidson street. Ten feet below this limestone is a hard grey shale with *Dawsonia, Phyllograptus, Dichograptus* and brachiopods.

By following the first street leading southward from Main street at the top of the hill, conglomerate B may be seen in more detail. At first sight this appears to be conglomerate A, but by following it along the surface, with almost every foot exposed, it is seen to run into a thin-bedded limestone at the top of the bluff. Returning to the cutting of the road, conglomerate A will be seen in place below conglomerate B. The cutting of this road gives an excellent opportunity to study the conglomerate in detail. Many of the pebbles are large, sometimes more than a foot in diameter, usually more or less rectangular and not well rounded. The interstices between the larger pebbles are filled with smaller pebbles, and there is very little paste. Most of the pebbles are of limestone, and many of them are fossiliferous. The fossils obtained here were chiefly of Beekmantown age. Some of the pebbles are themselves derived from a conglomerate, and others are composed of an oolitic limestone. Besides the limestone, pebbles of gneiss, quartzite, sandstone, and shale may be seen in this exposure.

LEVIS TO MONTMORENCY FALLS.

An excellent view of Quebec may be had from the ferry while crossing from Lévis to Quebec. On the highest point is the Citadel, while about half way down the cliff is the Dufferin terrace and the Chateau Frontenac. The rocks which form the cliff are limestones and hard shales of the Quebec City formation (Middle Trenton).

After leaving the Quebec Ry. Light and Power Co. railway station, the St. Charles river is soon crossed by the electric tramway, and the route proceeds along the low land near the shore until Beauport is reached.

At Beauport (2.8 miles, or 4.5 km.) a quarry in the Trenton limestone shows the strata to be thin-bedded, pure, blue-black limestone with thin shaly partings belonging to the middle division of the Trenton. Immediately beyond this quarry the train leaves the main line of the railroad and begins to mount the terrace. On this rather steep slope a cut has been made, exposing the Utica shale. This shale has a steep dip toward the river, whereas the Trenton strata in the quarry are horizontal. A fault which will be observed at Montmorency, passes between this cut and the quarry. Reaching the edge of the terrace. the railroad crosses the sloping top until it approaches the Beauport-Montmorency highway, which it parallels for the remainder of the distance. Numerous small quarries and lime kilns to the north of the railroad show the presence of the Trenton limestone along the highway—the railroad itself remains upon the Utica and Lorraine shales up to a point within a few rods of Kent House at Montmorency Falls. The highway is lined on both sides with the quaint houses of the French Canadians, whose long, narrow farms extend to the river on one side and to the Laurentian hills on the other.

MONTMORENCY FALLS; (A) CREST OF FALLS, WESTERN SIDE.

From this point one gets a good general view of the locality. The crest of the fall is 274 feet (83.5 m.) above sea level, and the look-out point, on top of the building by the dam, is about 320 feet (97.5 m.)—A.T. In the bed of the river is pre-Cambrian gneiss, and across the stream, the Trenton limestone is seen resting uncon-

formably upon the gneiss, but with a dip conforming to the slope of the surface of the older rock. Below the falls is a great thickness (700 feet, or 215 m.) of thin-bedded, micaceous shale of Lower Lorraine (Frankfort) age, and beneath it, 200 feet (60 m.) of black Utica shale. These shales, instead of being nearly horizontal like the limestones above the falls, dip to the southeast at an angle of about 40°. The face of the fall is on a fault plane, and the top of the Trenton, at the base of the fall, is 270 feet (82.3 m.) below the base of the Trenton at the top of the fall, thus indicating a drop to the south of about 600 feet (180 m.) All along the western bank of the stream may be seen the thin-bedded Trenton limestone, which is quite fossiliferous, both near the look-out and at the western end of the road bridge above. The fauna is that of the *Trinucleus* zone, in the lower part of the Trenton.

Across the north channel of the St. Lawrence lies the Island of Orléans, and the low area on the nearer side of that island is composed of graptolite-bearing strata of the Quebec City formation, having about the same strike and dip as the Lorraine on this side of the river, thus implying the existence of a thrust in the bed of the St. Lawrence.

MONTMORENCY FALLS: (B) CREST OF FALLS, EASTERN SIDE.

While crossing the bridge above the falls, the ridges of gneiss on the eastern side of the river, both above and below the bridge, should be noted. These ridges show the uneven character of the pre-Trenton surface. At the eastern end of the bridge, a path leads to the exposure on the bank of the river immediately below the concrete dam and just above the crest of the falls. Here the erosion of the rocks have revealed the bottom of the Trenton sea, and one may observe the *Solenoporas* growing on the sea floor, the calcareous mud filling hollows and cracks in the gneiss, and occasional boulders of the gneiss imbedded in the lower layers of the limestone. It will also be noted that the dip of the strata conforms to the irregularities in the sea floor, and that, while the unconformity here represents all of Cambrian and early Ordovician time, the basal conglomerate is insignificant in amount, indicating that this point was some distance off shore.

These beds are the oldest at this particular point; at the foot of a dam about one-half mile up the stream somewhat older beds outcrop which contain the oldest Trenton faunules, namely those with *Trocholites canadensis* and *Parastrophia hemiplicata*. All of the beds are newer than the Black River. On the weathered surfaces just above this exposure fossils are quite common, *Trinucleus concentricus* and *Eheirocrinus logani* (plates only) being most abundant.

From the crest of the falls on the eastern side of the river it is possible to continue down along the top of this bank, and near the point of the bluff facing the St. Lawrence, fossiliferous gravels of the Champlain period will be found with *Mya truncata, Saxicava, Macoma,* barnacles, and other fossils. Then, descending the dip slope to near the railroad tracks, one may find specimens of *Triarthrus becki* and graptolites in the Lorraine shales.

MONTMORENCY FALLS: (C) BASE OF FALLS.

While descending on the elevator to the basin below the falls the Lorraine shales on both sides of the river may be seen. Proceeding up stream toward the falls, Lorraine-Utica shales are seen in the bed of the stream. Near the base of the falls, the fault-contact between the Utica and the gneiss is crossed. From this point there is an excellent view of the pre-Cambrian gneiss along the fault plane, and in the direction of Kent House, the horizontal beds of the Trenton may be seen resting on the gneiss. A short distance up the bank on this side a crushed zone within the pre-Cambrian rocks indicates a movement parallel to the general fault, but the horizontal limestone above crosses this fault plane without interruption, thus showing that it is of pre-Trenton age.

Across the stream a small gully heading to the east has the gneiss for its northern wall, and at the bottom are a few layers of Upper Trenton limestone, followed by more limestone with *Triarthrus becki* and graptolites. The greater part of the southern wall of the gully, however, is shale, and the contact of the Utica and the Lorraine may readily be seen, the Utica shale being much the darker of the two. The contact is a very irregular one, but this irregularity probably does not indicate an unconformity, but rather that the

effect of the fault has been to cause the Lorraine to slip somewhat upon the Utica. The point of rock which is so constantly bathed by the spray is Utica shale, and graptolites, chiefly *Climacograptus bicornis* and *Climacograptus typicalis* are quite plentiful on the side toward the falls. The Lorraine shales are not, in general, very fossiliferous, but certain layers contain a quantity of graptolites and incomplete specimens of *Triarthrus becki*.

SPECIAL POINTS OF INTEREST: QUEBEC CITY.

1. Sous le Cap and Champlain Strects.

Sous le Cap is an exceedingly narrow and not very pleasant street or alley under the cliff, and is constantly shown visitors as the "narrowest street on the American continent," or the "narrowest street in the world." Passing close to the cliff it affords an occasional glimpse, on the north, of the shales and limestones of the Quebec City formation. Sous le Cap ends at St. Jacques street, from here, after turning into Sault au Matelot and continuing to Côte de la Montagne, one should turn up the hill and stop a few moments to examine the faulted and crushed conglomerate in the face of the bluff. The pebbles here are quite fossiliferous, and contain the Lower Trenton fauna with *Nidulites*, *Ampyx*, *Tetraspis* and other fossils of the Atlantic facies.

Faulting has in large part been responsible for the structure shown in this cliff face, and the first impression conveyed is that this is not a conglomerate, but that the pebbles are due to the disruption of regular layers. After a comparison of this outcrop with others about the city, however, it is believed that this is really a conglomerate torn up and softened by the crushing which has taken place in the faulting.

By re-traversing Côte de la Montagne and turning into Notre Dame street, one passes the church of Notre Dame des Victoires, built in 1668. At the second corner, by turning into the Cul de Sac, the headquarters during the French *régime* of the rich pawnbrokers, one reaches Champlain street. Coming out of the Cul de Sac, the vacant space on the left is the old Champlain market. Beyond the Champlain market on the north, above the road, the nearly vertical limestone of the Quebec City formation is seen surmounted

by the Dufferin terrace. At the further end of the terrace traces may still be seen of the great landslide of 1881. The strata here have a steep dip into the cliff. The upper ends of the beds formerly overhung the road, but finally they gave way and crashed down into the houses lining the road beneath, killing many people.

Beyond this point the nearly vertical strata, limestone and shale, form a great cliff along the north side of the road. The shale has in places a secondary cleavage. Although extensive search has been made for fossils along this bluff, the work of various collectors for many years has been rewarded by only one or two badly preserved graptolites.

A tablet on the face of the cliff marks the spot where, in an engagement on the last day of the year 1775, the troops from the revolting colonies of America besieging Quebec were defeated with the loss of their leader, General Montgomery.

Beyond this tablet the road follows the foot of the cliff, which reaches its highest point at Cape Diamond, where a slight turn in the road shows a change in the strata to thin-bedded dark shales with interbedded sandstone at a flight of steps leading up the cliff. The shales have afforded a few badly preserved graptolites which suggest that the soft shales are of Lorraine age.

2. The Northern Face of the Cliff separating Upper and Lower Towns.

The exposures along this cliff may be reached from the Quebec Ry. Light and Power Co. railway station by crossing St. Paul street and proceeding through the side street to St. Valier, nearly parallel to St. Paul. Following St. Valier west, one crosses Côte du Palais near the site of the old Palais gate, thence the route follows along below the wall of Upper Town. To the right of the stone building in the corner of the wall is the site of the Palais of the old French governors of Quebec. On the left, when nearing St. Roch street, may be seen the limestones, shales and limestone conglomerates of the Quebec City formation. A block further along St. Valier street, the strata can be examined in detail at a stairway on Côte à Coton, the limestone conglomerate being well shown near the top of the steps, just at the base of a retaining wall. Many of the

pebbles in this conglomerate are fossiliferous, the fauna being the same as that found in the pebbles on Mountain Hill.

An iron stairway on the left of St. Peters Church gives another good view of the strata. A short distance beyond this stairway at the Côte d'Abraham is an excellent exposure of the conglomerate, from which a large number of fossils have at various times been obtained.

The Quebec City formation is still to be seen at Côte de la Négresse, beyond which point the cliff is partially concealed by buildings and vegetation, but below the Martello tower and thence to the Boulevard Langelier, the thin-bedded, grey, micaceous shales of the Lorraine are exposed, with much the same strike and dip as the Quebec City formation. Up the hill, above the shales, the harder shales and limestones of the Quebec City formation have been exposed in trenching for city improvements, and the indications are that the Quebec City is thrust over the Lorraine, instead of the two lying side by side, as in a normal fault. The Lorraine here has afforded numerous specimens of *Diplograptus pristis* and small brachiopods of the genus *Dalmanella*.

Continuing along Arago street the bluff may be climbed at Côte Sauvageau, where the soft shale is in marked contrast to the hard limestone and shales seen at Côte à Coton and Côte d'Abraham.

After climbing Côte Sauvageau to the point of intersection with Reservoir hill, by descending that hill 200 feet (60 m.), the thin-bedded, soft, grey micaceous Lorraine shales will be encountered. Certain layers in this shale contain a great abundance of graptolites.

A hundred feet further down the hill are hard red sandstones, and from that point west the bluff is composed of shale and clay of the Sillery formations, this being apparently the point of exit of the fault which enters the bluff at Wolfe's Cove on the St. Lawrence side of the city.

Returning up the hill, on a path at the right side of the street formed by the junction of the two hill streets, may be seen a thin bed of limestone conglomerate between layers of the shales. A limestone conglomerate in the Lorraine is a very unusual thing, probably never noted outside this particular area.

From this point also, a good view may be had of the broad, flat-bottomed, deserted channel of the St. Lawrence, a branch of which once flowed to the north of the city.

SPECIAL POINTS OF INTEREST: LÉVIS.

Leaving Main street, at the foot of the bluff about 650 yards (600 m.) east of the railway station at Lévis and proceeding eastward along the Intercolonial Railway tracks, it will be noted that the face of the bluff here is free from the conglomerate. At the left of the track, however, there is a conglomerate (marked C on map) partly submerged at high water, which strikes toward the railway track, and, in the first cutting crosses the track and forms the face of the bluff to the right. This conglomerate is very different in appearance from those to be seen along the cliffs bordering Main street as it contains more matrix and fewer pebbles, weathers to a peculiar brown, is much streaked with calcite, and contains a good deal of sand.

At the end of this little cutting, this heavy conglomerate disappears. On the left hand side of the track the strata are much disturbed, and while there are two lenses of rusty conglomerate on that side, the main mass of conglomerate does not cross. At the right there is a small offset in the bluff, and on the face a conglomerate like the heavy one just mentioned is seen emerging from the bluff. On the top of the bluff, near St. Joseph road opposite the end of Côte des Pères, this conglomerate is seen again, but cannot be traced much further. It seems that the rusty conglomerate has been thrust by another cross fault a little southward.

About 400 feet (120 m.) further along the track, there is another offset in the bluff, and again the rusty conglomerate seems to be thrown southward, and this time it crosses the track in a small cutting, and disappears.

This cutting is one of the best localities for graptolites in this vicinity, and the position of this graptolite bed in the section is therefore of considerable interest. Up the hill from the graptolite bed is a conglomerate band about 100 feet (30 m.) above it. Fortunately this band can be traced with considerable certainty to connect with the lower of the two bands in the bluff section (conglomerate A., see Lévis guide above). It is of course a question whether the graptolite layers stratigraphically belong 100 feet (30 m.) below this conglomerate A, or 20 feet (6 m.) below the rusty one. It seems that the former is the case, because, firstly, there is

a zone of badly crushed and slickensided shale between the lower, rusty conglomerate and the graptolite shale, and secondly, the fauna is like that found in the shales of the bluff, *Dichograptus octobrachiatus* and *Phyllograptus anna* being the more characteristic species.

Beyond this cutting, a path leads up through the bushes to the top of the bluff. Near the top of the bluff is a limestone conglomerate similar to one exposed on the street above St. Joseph road. The conglomerate contains thin-bedded layers of limestone. It is here very thick, but this thickening is due to a doubling on itself in a synclinal fold. Following this path southward, to the highway and thence to and along St. Joseph road to Bégin street and up this street, no strata are exposed until a lane is reached leading to the quarries on the hillside. Just at the entrance to the lane a band of limestone conglomerate is exposed, another occurs a short distance further, and a third makes a prominent ridge just north of the quarries which are themselves in a conglomerate.

In the two quarries opened in this highest ridge there are very large masses of limestone, one of them 35 feet (10.6 m.) in diameter. It is hardly possible to consider them boulders, and, moreover, both these larger masses and the brown weathering paste contain fossils of Beekmantown age. Other pebbles in the same quarry contain Upper Cambrian fossils, and there are some large pebbles of sandstone, notably one just at the left of the eastern quarry. The ridge is therefore a conglomerate, but a large part of the material seems to have come from a limestone layer disrupted *in situ*. The first ridge north of this contains the same sort of large limestone masses with Beekmantown fossils, and it is thought that the two conglomerates are identical, and form the arch of an overturned and eroded anticline. The two conglomerates exposed to the north in the lane are duplicated in the cemetery back of this ridge.

This ridge is the "ridge north of the St. Joseph cemetery" mentioned by Ells, and it was here that Walcott first found fossils in the matrix and was thus enabled to make a definite correlation with the Beekmantown at Philipsburg.

QUEBEC AND VICINITY: PHYSIOGRAPHICAL NOTES.

(J. W. Goldthwait.)

The commanding position of the old city of Quebec, on the heights above the St. Lawrence, affords opportunity for observing to best advantage the broader features of the St. Lawrence plain. From Dufferin terrace and the citadel, as one looks down the estuary, he sees on the left the massive forms of the Laurentian mountains stretching away into the distance behind the north shore. Along their irregular border Pre-Cambrian gneisses disappear under the steeply upturned edges of Palæozoic limestones and shales, showing how the long continued denudation of Tertiary time failed by several hundred feet to reduce the crystallines to the level of the adjoining sediments. Midway in the estuary the Island of Orléans with its flat top 250 feet (76 m.) above the St. Lawrence, appears as a connecting link between the narrow plain that lies at the foot of the mountains on the one hand, and the broad lowland of the St. Lawrence on the other. Beneath the smooth skyline of this St. Lawrence plain the river and its small tributaries are deeply intrenched. Here at the narrowest point on the estuary the Plains of Abraham on the north side and the Lévis hills on the south, stand about 300 feet (90 m.) above tide, with precipitous cliffs bordering the St. Lawrence. From the river southward the plain rises slowly and steadily 12 or 13 miles (19 or 21 km.) before it reaches the first definite line of ridges on the southeast. This great St. Lawrence lowlands appears to be a peneplain, like the Cumberland, Colchester, and Eastern New Brunswick lowlands, developed on the soft Palæozoic sediments that lie between the hard gneisses of the Laurentides on the north and the resistant sandstone belts of the Appalachian ridges on the south. Uplifted, like the other lowlands, in mid-Tertiary time, it has been widely dissected by the river and its tributaries, and subsequently drowned. The tide now runs up the St. Lawrence to Lake St. Peter, 80 miles (128 km.) above Quebec. For at least

a part of the Pleistocene period the valley stood even more deeply beneath the sea.

According to Chalmers, the glacial history of this region is very complex; for there seem to have been three systems of land ice in the field: first an ice sheet appears to have spread from the Appalachian highlands of southern Quebec and New Hampshire northward as far as the St. Lawrence; next came an invasion of ice from the centre east of Hudson bay which crossed the St. Lawrence as far east as Quebec but not farther; and finally there is thought to have been a southwestward movement of ice from the Laurentian mountains. Local glaciers seem to have descended from these mountains in the closing stages and floating ice drifted up the estuary, which at that time was much deeper and wider. Marks of this drifting ice are found at various points on the south shore. The evidences of these several stages or epochs of glaciation cannot be regarded as yet sufficiently in hand to justify conclusions regarding them.

At the close of the last Glacial epoch the region around Quebec stood approximately 600 feet (180 m.) lower than now. By a differential upwarping, the old seafloor sediments and associated shorelines have been lifted to their present height above the sea. The obscure character of these raised beaches suggests that the land was already emerging from the sea when the ice sheet melted away, and that it continued to rise rather steadily and rapidly until approximately the present altitude was established. Gravelly beaches on the hills behind Chateau Richer, 15 miles (24 km.) east of Quebec, stop abruptly at 587 feet (178.9 m.). A similar upper limit to wave-washed deposits appears on the road running inland from St. Joachim, 10 miles (16 km.) farther east, at about 570 feet (173.7 m.). At. St Gervais, 15 miles (24 km.) southeast of Quebec, a well built bar of gravel stands 632 feet (192.6 m.) above the sea. These measurements harmonize with those for the upper marine limit along the south shore, where the water plane rises steadily towards Quebec all the way from Little Metis. Even though marine shells have been found only part way up to this level, as for instance at 375 feet (114.3 m.) at Portneuf, 30 miles (50 km.) west of Quebec, it seems certain that the submergence registered by the gravels at 600 feet (180 m.) is also marine.

Along the electric tramway from Quebec to Ste. Anne de Beaupré there is an opportunity to see the Micmac sea-cliff and shelf, the strongest and most continuous of the old shorelines of the lower St. Lawrence. In the town of Quebec itself, the twenty-foot terrace is obscured by the streets and buildings of the old town. On the Lévis shore several fragments appear. After crossing the delta-like flats at the mouth of the St. Charles river, near Beauport, the trolley line comes close up to the foot of the steep sea-cliff of this ancient shoreline. From Beauport all the way to Ste. Anne and St. Joachim, at the end of the railway, the cliff is continuous and nowhere far from the track. It is a precipitous turf-covered bank, from 20 to 50 feet (6 to 15 m.) high. While its course instead of being straight is gently curved, there are no marked irregularities, neither bold headland nor sharp re-entrant. It is a typically "mature" coast. From the foot of the cliff the terrace slants gently outward for several hundred yards to the present high tide mark, and continues in the form of half submerged mud flats for an equal distance offshore. Its total width, from the foot of the bluff to the outer edge of the flats ranges from half a mile to a mile and a half (0.8 to 2.4 km.) Across the channel, on the north side of Orléans island, one can see a similar shelf and bluff. This extends completely around the island.

At a number of points along the railway it is possible to see that the cliff has been cut back not simply in glacial drift, but in hard rock. At Eglise de Beauport, for instance, fresh cuts in the face of the Micmac bluff show soft slates dipping seaward at a steep angle, nearly coincident with the slope of the bluff itself. One might conclude that the escarpment was not a wave-cut cliff but merely a structural one, if he saw it at this locality only. At Montmorency Falls, likewise, the red shales, deeply decayed, appear behind the cliff in cross-section in the walls of the gorge. The fall itself lies on the boundary between these shales and the more resistant gneisses, upon which the river has been held, while it has excavated the deep gorge in the shales below. Continuing along the inner edge of the Micmac terrace to Chateau Richer, the railway passes in sight of quarries on the face of the bluff where limestone instead of shales are exposed. Clearly the bluff has been trimmed back into the coast without regard for the strike or the dip of the rocks.

Beyond here the terrace broadens and runs uninterruptedly for many miles.

Two facts about this Micmac shore line are pre-eminent in importance. First, its strength, in view of the narrow limits within which waves could develop between the Island of Orléans and the north shore, is extraordinary. It has been cut back as far into the coast as the distance across the shelf—or over half a mile. Secondly, the altitude of the shelf here near Quebec is almost exactly the same as its altitude 300 miles (480 km.) down the estuary; and in the interval there are no signs of local warping. This recent emergence of the coast of the lower St. Lawrence within the limits stated was a perfectly uniform uplift.

A study of the flora of the Micmac terrace at Ste. Anne de Beaupré shows a striking intermingling along the high tide zone of salt marsh plants and fresh water plants. This might be interpreted to mean that the fresh marsh is gaining on the salt, and that the plants from the inner marsh are advancing out over the tide marsh as fast as the coast rises. On the other hand, it might be interpreted to mean that the salt marsh plants are invading what was formerly fresh marsh, during a slow subsiding of the coast. And finally, it is possible to regard the intermingling of the two flora as the result of the varying effects of high tides and seasons of heavy rainfall, which now flood the marsh with salt or brackish water and then fill it temporarily with fresh. So far as can yet be discovered, there is no way to demonstrate whether the Micmac shelf is still slowly emerging from the sea, or is stationary, or is slowly subsiding. In general, recently collected facts from the New Brunswick and New England coast favour the idea that no change of level has occurred during the last few thousand years.

GRAPHITE AND MICA DEPOSITS NEAR BUCKINGHAM, QUE.

*By J. Stansfield.**

THE GRAPHITE DEPOSITS AT THE WALKER MINE.

GENERAL GEOLOGY OF THE LOCALITY.

Grenville limestone, the oldest Pre-Cambrian rock in this locality, occurs on the hill above the smaller millpond and to the south of the larger pond. Also, in the northwestern part of the area it is represented by a broader band which extends in a direction somewhat east of north. This limestone band is flanked on either side by Ottawa gneiss, the most important member of which is a quartz-rich variety, very similar in appearance to the hypersthene-granites of the Emerald mine. Small graphite bodies are occasionally seen in this gneiss, more especially on joint faces. Pegmatitic phases are developed in the extreme northwestern corner of the area. Small amounts of para-gneisses may be included in this igneous complex, but as yet none have been definitely recognised.

The larger part of the map area is occupied by more basic varieties of Ottawa gneiss than those just described. They consist of gabbros and diorites with pyroxenite, amphibolite, anorthosite and hypersthene-gabbro basic variations. Scapolite is of common occurrence in these basic gneisses, which appear to be younger than those described above. In the northern part of the map area a younger gabbro has been separated from the other basic gneisses, but otherwise the relative ages of the intrusions constituting the basic part of the complex remain unknown.

At a distinctly later period in Pre-Cambrian time, the Grenville limestone and Ottawa gneiss were invaded by pegmatite, diorite

* Extract from Guide Book No. 3.—International Geological Congress, XIIth Session, Canada 1913.

and gabbro dykes, which probably represent more than one magmatic intrusion. The graphite ore bodies are always found in close association with these dykes. One of the pegmatite dykes has graphite distributed throughout its mass in great abundance.

GEOLOGICAL RELATIONSHIPS OF THE GRAPHITE DEPOSITS.

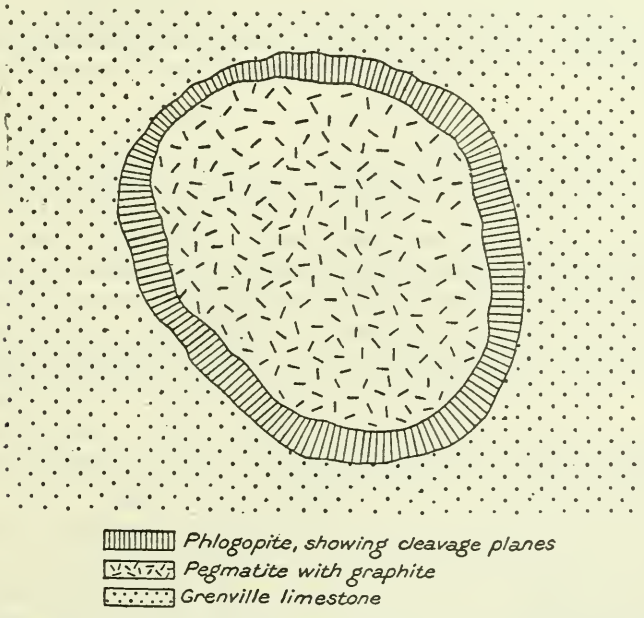
The main pit is situated at the foot of a cliff, which, from top to bottom, consists of biotite-diorite-gneiss, a horizontal dyke or sheet of biotite-diorite from 6 to 20 feet (1.8 to 6.1 m.) in thickness and a much altered limestone. Immediately to the south the limestone is also in contact with a biotite-rich gneiss, different in appearance from the biotite gneiss at the top of the cliff. The graphite ore-body is situated underneath the diorite sheet and at the contact of the limestone with the gneiss. The graphite is in the limestone rather than in the gneiss, though some of the latter is impregnated with graphite. The ore-shoot is about 30 feet (9.1 m.) wide and the same in length. It strikes N.S. and pitches 57° to the south, and has been worked by means of a tunnel, now filled with water. The ore-body and the igneous sheet above it can be likened to the stalk and head of a mushroom, an analogy which brings out the fact that the ore-body does not lie close to the contact of the intrusive and the limestone.

The altered limestone near the ore-body contains in addition to calcite a colourless monoclinic pyroxene, probably diopside; scapolite, which sometimes shows strain-shadows, and, as might be anticipated, has a birefringence near that of meionite; microline and a little plagioclase, both strained and often broken into small grains; and a considerable quantity of titanite characterized by strong reddish pleochroism. Graphite is associated with calcite and feldspar, more especially with the latter mineral and is for the most part of later formation than these minerals, though in some instances it preceded the feldspar. Pyrite was formed later than the graphite. The rock is banded in structure, some bands being richer in calcite than others. The graphite occurs mostly in the feldspathic bands. The whole rock gives evidence of having been subjected to pressure, subsequent to its alteration, the scapolite showing this more clearly than any other mineral. A thin section

of the ore consists chiefly of graphite together with some titanite, a later formed scapolite and still later pyrite which sometimes has grown along the cleavage cracks of the scapolite. The relation of the graphite to the minerals which accompany it is not shown, but the presence of these minerals indicates that the ore is an impregnated altered limestone, a conclusion which is also reached by studying the field relations.

At an opening 500 feet (152 m.) north of the main pit, graphite forms bodies one foot in width on both sides of a pegmatite dyke. The flakes of graphite are parallel to the walls of the dyke, and are regarded as impregnations of the country rock. The ore here and at the main pit belongs to the type known as "disseminated ore."

At the now overgrown openings at the extreme south-western corner of the map area (Nelly group of Osann) [2], the ore occurs as "vein or columnar graphite." So far as can be seen from the poor exposures, the veins containing graphite are developed near the contact of a gabbro with Grenville limestone. A few specimens



Radial phlogopite rim between graphitic pegmatite and Grenville limestone, Walker mine.

of the columnar graphite may be obtained from the dumps, which also furnish apatite, titanite, scapolite and pyroxene, the associated minerals of the graphite veins. Titanite crystals up to the size of a hazel nut can be found and also pyroxene combs like those of the apatite and mica veins. The graphite, where found in place, has its fibres at right angles to the walls of the vein. The veins range up to four inches (.1 m.) in width.

Osann describes a gabbro from this locality, which has many features in common with the gneiss capping the hill at the main pit. This rock is coloured as gabbro on the map.

At a point above the smaller mill-pond, Grenville limestone is intruded by a small patch of pegmatite, which carries graphite within its mass, and is separated from the limestone by a rim of phlogopite in which the flakes of the mica are set at right angles to the margin of the pegmatite block.

Graphite was first shipped from this locality in the seventies, but at that time only columnar graphite was marketed. The main pit was worked from time to time between 1890 and 1896. The ore was first roasted in kilns and then treated with water to make it more readily crushable, and the graphite was separated by a wet process.

THE GRAPHITE DEPOSITS AT THE DOMINION MINE.

In the vicinity of the Dominion mine, Grenville limestone and a small amount of associated sillimanite-gneiss have been intruded by mica-syenite-gneisses. These, in their turn, have been intruded by quartz-pyroxene-gneisses comparable to the hypersthene-granite-gneisses of the Emerald mine, and by diorites, pegmatites and gabbros. The age relations of these various intrusives are not always clear; the nearest approach to a chronological order, at present possible, is shown in the legend of the map. Many small pegmatite and diorite dykes occur in the gneisses of the area.

The rocks that command attention most are the varieties of gabbros with which the graphite ore-bodies are associated. These have intruded the Grenville limestone and older gneisses and have caught up masses of limestone within themselves. Graphite has been deposited either at the junction of the igneous rock with its

country rock, or in the included masses of limestone, or in the body of the igneous rock itself. Hence, the ore may be impregnated gneiss, impregnated limestone, or impregnated gabbro or pyroxenite. It occurs in the form known as "disseminated" graphite, but not as "vein or columnar" graphite.

The occurrence at the main pit is the most instructive. Here the ore occurs in a shoot of roughly lenticular cross-section, which sends offshoots or stringers into the surrounding rock. The whole ore-body occurs within a mass of gabbro, in which there are also "horses" of limestones, near which the graphite is more concentrated than elsewhere.

The gabbro appears to be a normal type, except that it sometimes contains small quantities of quartz and of graphite.

Both gabbro and ore are cut by "blue quartz veins," which seem to be the latest products of the gabbro intrusion. These veins are composed largely of quartz filled with minute inclusions, a variety of hornblende showing grass-green, drab and light yellow pleochroic tints being the only other mineral of importance. A little pyrite and graphite are the only other minerals present. The graphite is in part earlier than quartz, and in part later.

A sample of ore from this pit proved to be a pyroxenite composed mainly of grey augite. Brown, strongly pleochroic biotite is common; orthoclase, a smaller amount of plagioclase, titanite with strong reddish pleochroism, interstitial quartz, and a minute quantity of brown hornblende are also present. Pyrite is older than the pyroxene, but graphite is one of the latest minerals to be formed. It occurs along the cleavage cracks of biotite, and at some points can be seen penetrating two adjacent grains of feldspar or of quartz. The presence of quartz in a pyroxenite is another interesting feature.

Other minerals associated with the graphite are apatite, in masses up to the size of a hen's egg, pyrite, sometimes as veins of honeycomb or drusy nature cutting the ore, and molybdenite, of which a few flakes have been recognized.

Some examples of the calcareous ore, from their appearance in hand-specimen, indicate that the calcite, though probably derived from the limestone, was dissolved by the waters accompanying the igneous intrusion and re-deposited from solution, along with the

graphite. This calcite has a distinctly different appearance from that of the ordinary Grenville limestone.

About 200 feet (61 m.) southeast of the main pit is another opening, in which one of the blue "quartz veins" is seen cutting Grenville limestone. A dense aggregate of graphite flakes reaching a thickness of one foot was found on both sides of the vein.

At the swamp pit, not now exposed, highly altered limestone is in contact with a biotite-gabbro, which is cut by "blue quartz veins." The ore, which attained two or three feet (.6 to .9 m.) in thickness, was entirely within the gabbro.

An interesting section is to be seen at the opening in the south face of the Pre-Cambrian area. At this point, where the rocks have a dip of 60° to the north, there is a band of ore one foot (.3 m.) thick at the contact between sillimanite-garnet-gneiss and an overlying limestone. Near the ore the limestone is dark blue in colour with lighter yellowish patches in it up to the size of a hazel-nut. Above this the limestone is coarsely crystalline. The cause of this colouration is not known.

The Dominion mine was opened up in 1910 and the mill was erected in the latter part of that year. Work was continued until the latter part of the summer of 1912. The ore is roasted in kilns at the top of the hill so that it may be more readily crushed, and passes by gravity through a series of crushers. On reaching the mill the graphite flakes are flattened and separated by a dry process, the fine rock powder passing through rotary screens which do not allow the graphite to pass.

THE MICA DEPOSITS AT THE NELLIS MINE.

NEAR CANTLEY, P.Q.

GEOLOGICAL RELATIONSHIPS OF THE DEPOSITS.

The veins worked at the Nellis mine occur on two "hills" separated from each other by a clay filled hollow, in which a small post-glacial creek has cut a deep valley.

On the north hill, it may be seen that the Ottawa gneiss is intruded by a small stock of scapolite gabbro, and by an elliptical intrusion of gabbro-pegmatite. Mica-bearing veins cut all of these

rocks. The Ottawa gneiss is an augite gneiss similar to the granite-gneiss seen along the road, except that the gneissic banding is more strongly developed. It is cut, without regard to the direction of the gneissic banding, by mica-bearing veins. The greater part of the gabbro contains an important amount of scapolite in addition to augite and minor amounts of plagioclase, phlogopite, sphene, apatite and sulphides. A sugary anorthosite phase occurs at two points. Another variation from the average type occurs at the east central part of the stock. It is a black amphibolite, in some specimens of which epidote can be seen in the hand-specimen, though hornblende is the sole constituent of importance. The gabbro-pegmatite is composed of feldspar with a little quartz. The feldspar is chiefly microperthite with some microcline and plagioclase.

CHARACTER OF THE VEINS.

Mica-bearing veins occur more abundantly in the gabbro area than in the gneiss or gabbro-pegmatite. They form a parallel series, striking N. 68° E. (mag.) at the northern end of the hill, and swinging round to N. 23° E. (mag.), at the southern end. Only one vein runs at right angles to this general direction. The veins are about 15 feet (4.5 m.) apart on the average, and dip to the east from 37° to 87°. The vein walls are rectilinear in the gneiss and gabbro-pegmatite, but in the gabbro they are more inclined to irregularity. A banded vein structure is general, the typical vein having a comb of black or dark pyroxene crystals growing at right angles to the vein-walls and possessing terminal faces on the ends which project into the vein. Next to each pyroxene layer is a band of mica crystals, with their cleavage planes more often parallel to the vein-walls than at right angles. Each mica layer is succeeded by one of green apatite, and the centre is filled with pink or white calcite. Individual veins may lack the apatite, or the calcite, but more often the two occur together in the centre, perfectly formed apatite crystals being embedded in the calcite. Sometimes perfect crystals of phlogopite are also found embedded in the calcite. The calcite gives a strong strontium flame reaction. Quartz, fluorite, tourmaline and actinolite are of less frequent occurrence.

Some of the veins follow lines of faulting. Sometimes also they are displaced laterally for a few feet, but whether this is due to

subsequent faulting or to an original discontinuity of the fractures cannot be determined under present conditions. Changes in thickness of the veins are more common in the gabbro than in the other types of country rock. Bulging and narrowing of the vein is especially well seen along the main lead. The same variation is shown in depth, a vein which may be only one foot (.3 m.) in width at the surface widening to 10 to 15 feet (3 to 4.5 m.) underground. An example of this can be seen at the south face of the hill. This characteristic is recognized in prospecting, and further work on apparently lean veins at the surface has been rewarded frequently by the discovery underground of wider veins carrying important bodies of mica. At present the veins are being worked for mica, the apatite being taken out and stocked on dumps.

The south hill is occupied by a mass of binary granite intruded by a dyke-like mass of scapolite gabbro similar to that occurring at the north hill. The veins are found more especially along the eastern face of the hill near the gabbro dyke, and strike parallel to those of the north hill. The veins are exactly similar to those seen on the north hill, except that calcite is almost lacking, and the apatite is usually of a reddish colour rarely seen on the north hill.

ASBESTOS AND CHROMITE DEPOSITS OF THE PROVINCE OF QUEBEC

By Robert Harvie *

INTRODUCTION.

The purpose of this excursion is to examine the character and mode of occurrence of the asbestos and chromite deposits of Quebec, and to observe the methods of mining. At Thetford and Black Lake the asbestos occurs in an igneous intrusion of stock-like proportions, while at East Broughton it occurs in a sheet or sill. The most typical deposits of chromite may be examined at Black Lake.

The district yields over three quarters of the world's supply of asbestos, with an annual value, at present, of about $3,000,000.

The first geological work in the asbestos district was carried on under Sir William Logan prior to the discovery of the more important bodies of asbestos bearing rocks. Sir William drew attention to the economic possibilities of these rocks, and gives a large amount of general information about them in his "Geology of Canada, 1863."

Subsequent reports of the Geological Survey of Canada added to this information, the next important advance being the reports by R. W. Ells in 1886 and 1888, which give the results of more detailed mapping after the development of active mining. In 1903 a Bulletin on Asbestos was published.

A monograph by Fritz Cirkel was issued by the Mines Branch in 1905, which describes the occurrence, uses, and methods of mining and concentrating asbestos. Chromite was also treated in a similar manner in a further report by Cirkel in 1909. Both these volumes deal more especially with the mining side of the subject, the geology receiving relatively much less attention.

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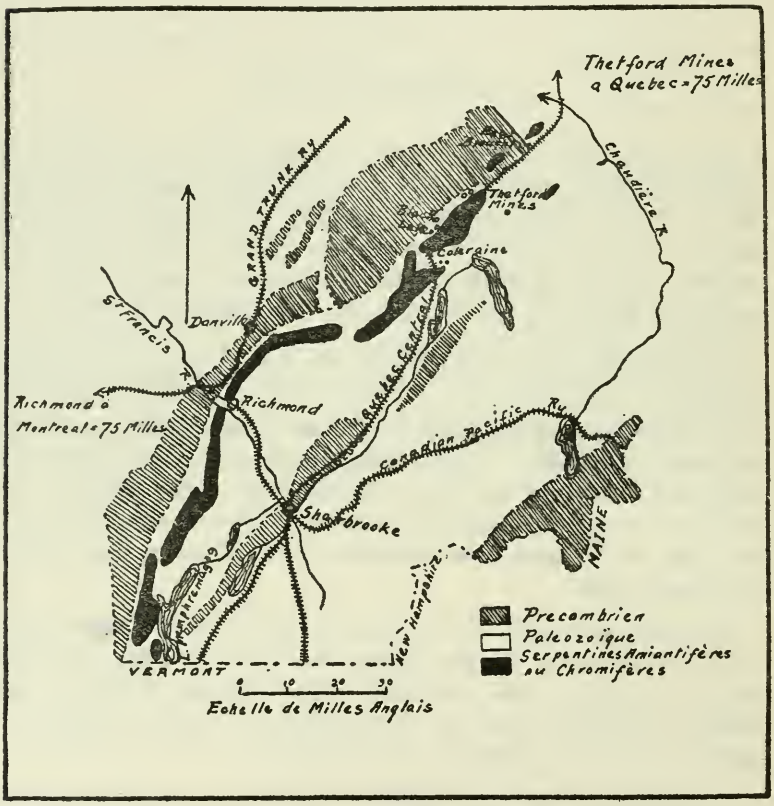
*Extract from Guide Book No. 2, International Geological Congress, XIIth Session, Canada 1913.

In 1907 a detailed examination of the serpentine belt in which the asbestos and chromite deposits occur was begun for the Geological Survey by J. A. Dresser. His reports of progress, appearing in the Annual Summary Reports of the Geological Survey for



Sketch map of the Asbestos region of the Province of Quebec.

1907, 1909 and 1910, give the fullest accounts of the geology of these deposits yet published. The general description of the asbestos producing area which follows is taken nearly verbatim from Dresser's Summary Report for 1909.

GENERAL DESCRIPTION OF THE ASBESTOS PRODUCING REGION.

Physical Features. — The portion of the Province of Quebec which lies south of the St. Lawrence river consists of two distinct parts: the St. Lawrence plain, and the Appalachian highlands. The St. Lawrence plain, so-called, is really a broad, flat valley, which, since its average gradient is scarcely 10 feet (3 m.) in a mile 1.6 km.) appears to be a level plain. Near the International Boundary line it extends southeast of the St. Lawrence river for a distance of 50 miles (80 km.), but grows narrower farther down the river, and terminates where the Notre Dame highlands reach the river about 100 miles (160 km.) below Quebec city. The St. Lawrence plain is part of the greater lowland which extends from the lower part of the St. Lawrence river to Georgian bay.

The highlands, which form the rest of the Province south of the St. Lawrence, are known in the Gaspé peninsula as the Shickshock mountains; while in the southern part of the Province, or Eastern Townships, they are sometimes called the Notre Dame hills. They are a northward extension of the Green and White mountains of New England, and form the most westerly member of the Appalachian mountain system in Canada.

The topography of the region is in an early stage of maturity. The altitude varies from 400 feet (122.m) to 2,000 feet (609 m.) above sea-level. The relief is characterized by numerous northeast and southwest ridges and valleys, and a smaller number of larger, transverse valleys.

The transverse valleys are those of the Chaudière, Bécancour, Nicolet, and St. Francis rivers. These rivers all follow northwesterly courses, and are tributary to the St. Lawrence. It is not yet known whether they are older than the present hills and have cut through them as they were elevated or have been superimposed upon them by the removal of later formations, remnants of which are found in the district.

The tributary streams often run in structural valleys, and are probably younger than the main rivers. They generally have

narrow valleys with steep sides, and frequently enter the main rivers by distinct falls.

These furnish the principal water-powers of the district, and have given rise to such manufacturing centres as the city of Sherbrooke, at the junction of the Magog with the St. Francis; and Windsor Mills, at the entrance of the Wattopekah to the same river.

General Geology.— Southeastern Quebec is underlain by strata of Palæozoic age, resting upon the Pre-Cambrian complex, which emerges from beneath the later rocks a short distance north of the St. Lawrence. The Palæozoic strata form an ascending series toward the southeast, except where folding and subsequent erosion have disturbed the sequence. Every geological formation from Cambrian to Devonian is represented.

The structure is far from uniform. In the northwestern part of the St. Lawrence plain, the strata are conformable from Potsdam to Hudson river. They are little disturbed in position, and dip toward the southeast at low angles, usually 5 to 6 degrees. This regularity ends abruptly at the St. Lawrence and Champlain fault, a great dislocation which extends from the foot of Lake Champlain northeasterly to Quebec city, and runs thence to the Gulf of St. Lawrence along or near the present channel of the river.

On the southeast side of this fault the strata are highly folded, and have otherwise suffered greatly from regional metamorphism. The conditions of deposition on this side were also different. The marine fossil fauna indicate cold, perhaps subarctic, conditions, and an unconformity is found at or near the base of the Ordovician, which is not found on the west side of the fault.

Over considerable areas east of the fault, the folded rocks have been planed down by erosion, so that they now underlie the eastern part of the St. Lawrence plain without expressing their structure in the topography. The sediments of the region consist of shales, limestones, and sandstones, with schists, slates and quartzites on the east side of the great fault.

The Highlands, or Notre Dame hills, consist of three parallel anticlinal ridges running in a northeasterly direction, with two broad, intervening basins, each of which has a width of about 25 miles (40 km.). The ridges are usually distinguished as the Sutton,

Sherbrooke or Stoke, and Lake Megantic anticlines. The last forms a part of the boundary line between the Province of Quebec and the State of New Hampshire. The first mentioned is the most westerly of the Appalachian folds in this region, while the second forms the Capelton hills and Stoke mountain, and the hills of Weedon farther to the north.

The ridges contain a considerable development of ancient volcanic rocks, porphyry and greenstones. These are overlain by sediments, some of which are probably of Pre-Cambrian age.

Closely bordering the southeast side of the Sutton ridge is a series of basic intrusive rocks. These rocks constitute the serpentine belt, and contain the deposits of asbestos and chrome iron ore. They extend from the Vermont boundary line, with little interruption, north-easterly to the vicinity of Chaudière river. Representatives of this series of rocks appear at frequent intervals in the eastern part of North America, from Georgia to Newfoundland. In Quebec they consist of peridotite and serpentine, pyroxenite, gabbro, diabase, porphyrite, hornblende granite and aplite, all of which are regarded as differentiates from a single magma. They form hills 1,500 feet (457 m.) in elevation, which in some parts cover 10 to 20 square miles in area. Other exposures are only a few hundred feet in width. The maximum width of any of these areas rarely exceeds 5 miles (8 km.) and is usually less than a mile (1.6 km.) In structure they are considered to form batholiths, or laccoliths, and intrusive sheets or sills.

Asbestos occurs in serpentine of two varieties which are thought to be of different ages. They may be conveniently called the Thetford and the Broughton types, and the rocks associated with them, the Thetford and the Broughton series, from townships in which they are well shown.

In the area to be described the rocks of the serpentine belt cut no rocks later than Sillery (Upper Cambrian), though they probably alter Ordovician strata. To the south of this district, however, in the county of Brome, they cut strata of Ordovician age. It is not yet proven that the rocks of the series were all intruded at or nearly at the same time. Two periods of intrusion have however been thus far determined, and others may yet be found. Hence the age of the series as a whole can only be determined approximately.

TABLE OF FORMATIONS.

1. Quaternary	Sands and gravels, stratified clay, boulder clay.
2. Ordovician-Farnham	Black slates, conglomerate.
3. Cambrian-Sillery	Red and green slates and sandstones.
L'Islet	Quartzose, grey schists and quartzite.
4. Pre-Cambrian	Porphyries and greenstones.
Intrusives—Post-Sillery; in part, at least, later than Ordovician—Thetford series	Peridotite, altering to serpentine, pyroxenite, gabbro, diabase, porphyrite, granite and aplite.
Post-L'Islet—Broughton series	Serpentine, soapstone, greenstone schists.

THETFORD SERIES.

The rocks of the Thetford series make up the greater part of the serpentine belt. In this district they extend southwesterly from Broughton mountain, in the township of Broughton, through Thetford, Coleraine, Ireland, Wolfestown and Garthby townships to Big Ham mountain. After an interval of 4 miles (6.4 km.) they reappear in Little Ham mountain, and continue in a southwesterly direction to Danville, and thence to the St. Francis river. Diabase covers the largest area of any rock of the series, peridotite and serpentine the next. Gabbro and pyroxenite also form considerable masses, while granite and aplite are of relatively small extent.

PERIDOTITE AND SERPENTINE.—Serpentine forms the country rock of all the mines, and, with less altered peridotite, makes up many of the larger hills in the mining district. The hills near Little Lake St. Francis, near Black lake, in the southern part of Ireland, and between Belmina and Chrysotile, as well as smaller areas in other parts of the serpentine belt, are composed of serpentine and peridotite.

PYROXENITE.—When pure, pyroxenite consists of the mineral pyroxene. There is usually present, however, more or less olivine or feldspar, the former if the rock is approaching the composition of peridotite, the latter if it tends toward gabbro.

The pyroxenite near the Danville asbestos mines is singularly coarse-textured, and much of it is composed of large pyroxene crystals, some of which measure 2 inches or more on single faces. In general, the pyroxenite is somewhat altered to soapstone.

GABBRO.—Granitoid rock types in which feldspar is present as well as pyroxene are classed as gabbro. The distinguishing feature of this rock is its coarse texture as exhibited in angular grains of grey feldspar and green pyroxene. It forms a large part of the hills above Lac Coulombre and Nicolet lake, and of Little Ham mountains. It may be seen along the roadside near the southeast shore of Black lake, and in many other places near the foot of serpentine hills. The pyroxene is sometimes altered to hornblende; the rock is then more correctly called a gabbro-diorite.

DIABASE.—The diabase has the same mineral composition as the gabbro, but is much finer grained, and generally has a quite different appearance. It is a fine grained, green rock sometimes showing small, grey grains of feldspar. In other cases no individual mineral can be distinguished by the unaided eye. The rock can often be readily recognized by nodules and stringers of yellowish-green epidote, a mineral that has been formed by the alteration of feldspar, and, in part, also of pyroxene. There is frequently a little quartz with the epidote.

Diabase may be well seen along the Quebec Central railway between Black Lake and Thetford; also near the Roman Catholic church at Black Lake. It forms the hills about Clapham lake, and

near the Little Nicolet lakes. It carries copper and iron pyrites, in places, as at Lac Coulombre. In places, by becoming more acid in composition and losing much of its pyroxene, the diabase passes into porphyrite near the outer edges of the mass.

Granite.—The granite, though limited in extent, is important, as it probably indicates conditions that favoured the development of asbestos. It forms hills in the northeastern part of Coleraine, dykes in most of the mines, and, in places, isolated masses grading into the enclosing diabase or porphyrite. These isolated masses are, probably, primary segregations.

Structural Relations.—The rocks of the Thetford series are obviously intrusive in their relations to the enclosing sediments. Evidences of this are: alteration of the sediments in the outer contact zone; deflection of their dip and strike; and development of contact breccias.

The alteration of the sediments is sometimes shown by a hardening of a band near the contact, producing a hornstone rim. The grey slates are often given a rusty, reddish colour, due apparently to the oxidation of sulphides developed near the contact, while the originally red Sillery slates are usually bleached to pale pink. Fragments in the breccia, and larger portions of sediments near the contact, show partial absorption by the igneous magma. Some of these rocks still preserve the lines of foliation of schists on weathered surfaces, but on freshly broken faces they cannot be distinguished from the enclosing, or adjacent, igneous rock.

Dykes are very rare, and altogether there is a very noticeable absence of evidence of any violent eruption. The intrusion seems to have progressed slowly, and without any marked cataclysmic action. The contact is thus of the batholithic order.

The bodies of igneous rock appear to take two principal forms. From Broughton mountain to Little Nicolet lake, where the igneous belt crosses the stratification somewhat obliquely, the intrusions occupy elliptical or rounded areas, bordered by breccia, and giving evidence of downward enlargement. With the exception of one district, and two doubtful intervals, they form a continuous mass, and so are interpreted as being a batholith, or very thick laccolith.

In other parts of the district, the boundaries of the intrusions conform more closely to the stratification, are generally brecciated on one side only, and occupy long narrow areas. In cross section they can sometimes be seen to form sills or intrusive sheets, and are consequently considered to more generally take this form.

The peridotite, pyroxenite, gabbro and diabase, form a continuous series, passing by gradual transitions from one variety to another, in the order named. In the case of larger exposures, all of these rock types can sometimes be found in a single intrusive mass. In other cases, the differentiation is sharper, and peridotite passes into diabase with only a few feet of transitional rock between. In general, peridotite, or the serpentine derived from it, and diabase, form the larger portion of a rock mass. At the outer edges, the diabase, in places, passes into hornblende porphyrite, and this occasionally into hornblende granite, or aplite.

The granite and aplite have usually, however, been intruded a little later than the more basic rocks. The edges of these acid intrusions are generally as well crystallized as the central parts, showing that they were brought in while the basic rocks were still heated. Occasionally, too, an injection of diabase has taken place somewhat later than the intrusion of the greater part of the mass. This may be seen at Louise mountain, in Garthby, and probably near Shipton Pinnacle, but such occurrences are not common.

The rocks of this igneous complex are generally distributed in one or other of two different modes of arrangement, according to the form of the igneous intrusion. They are arranged in order of decreasing basicity and density:—

(1) In sheets, from the base upwards.
(2) In batholithic intrusions, from the centre outwards.

Serpentine, or diabase may sometimes be much in excess of the other rocks, and thus give an asymmetric arrangement. But the more acid rocks, wherever present, are, as far as known, invariably near the tops of sheets or the margins of batholithic intrusions, and the basic rocks in correspondingly opposite directions.

In the case of sheets, the arrangement of the rocks accords with the relative densities of the principal minerals of which they are composed, and also with the order of their crystallization.

In the case of batholithic intrusions, the differentiation from basic to acid extremes, from the centre outwards, is in agreement with well known cases of magmatic segregation in intrusive rocks, where differentiation has taken place prior to intrusion.

The batholithic intrusions near Thetford characteristically consist of a dome-shaped central mass of peridotite, bordered, or sometimes nearly surrounded, by an erosion valley. The outer side of the central mass is formed by a ridge of diabase, or porphyrite, which again passes into breccia at its outer edge.

It may be mentioned that an identical relation of rock types has also been found in association with the platinum bearing peridotites of the Ural mountains.

BROUGHTON SERIES.

The Broughton series consist of serpentine, soapstone and greenstone schists. They are the rocks containing, and adjacent to, the asbestos and talc deposits of Robertson, East Broughton and Broughton, and of several isolated locations in the vicinity.

The greater alteration of these rocks indicates that they are possibly earlier in age than the Thetford series, although this difference may also be due to a greater degree of metamorphism. The sediments enclosing them are the grey schists and quartzites, in no case the red slates of the Sillery formation. It can, therefore, only be said of their relations that they are intrusive in, and hence later than the L'Islet formation which conformably underlies the Sillery.

ECONOMIC GEOLOGY.

The minerals of economic value that have been found in the serpentine belt are asbestos, chrome iron ore, talc, antimony, copper and platinum. Of these, asbestos alone is at present being mined, the production of which represents one-half of the total mineral production of the Province of Quebec, and is upwards of 80 per cent of the world's output of asbestos. Chromite has at times been produced in considerable quantity, but the industry has never passed the prospecting stage and at present operations have ceased

altogether. Antimony and talc have been mined; there has been a small development of the copper ore; and platinum has been found in the gravels.

The discovery of asbestos as a mineral of commercial importance was made in this district in 1877, although it was known for many years previously as a mineral of prospective value. Mining operations began at Thetford, Black Lake, and very shortly afterwards at Danville, and have continued ever since. Since the introduction of a successful method of mechanical concentration, about 1893-4, the production has increased regularly, until it now has an annual value of about $3,000,000. Notwithstanding this steady and increasing production, no well-established mine has yet been worked out. Aside from the abandoned pits incidental to early prospecting, the only closed works are those of ill-judged enterprises that probably ought never to have been begun.

The production for the past ten years has been as follows:—

Year.	Tons.	Value.
1902	30,634	$1,161,970
1903	29,261	916,970
1904	35,479	1,186,795
1905	48,960	1,476,450
1906	62,375	2,143,653
1907	61,985	2,455,919
1908	65,156	2,551,596
1909	63,349	2,284,587
1910	100,430	3,403,358
1911	100,893	2,922,062

Various attempts to mine chrome iron ore in Quebec were made between 1860 and 1890, but it was not until 1894 that any considerable production was made. Between 1894 and 1908 over 40,000 tons of chromite were mined, which had a value at the railway of about $600,000. Since 1908 the industry has declined, till at present none of the deposits are being worked. The development of new ore bodies has not kept pace with the exhaustion of those being worked.

The following production during the last four years of active work was as follows:—

Year.	Tons.	Value.
1905	8,528	$104,585
1906	8,750	92,100
1907	7,196	72,901
1908	7,225	82,008

BLACK LAKE.

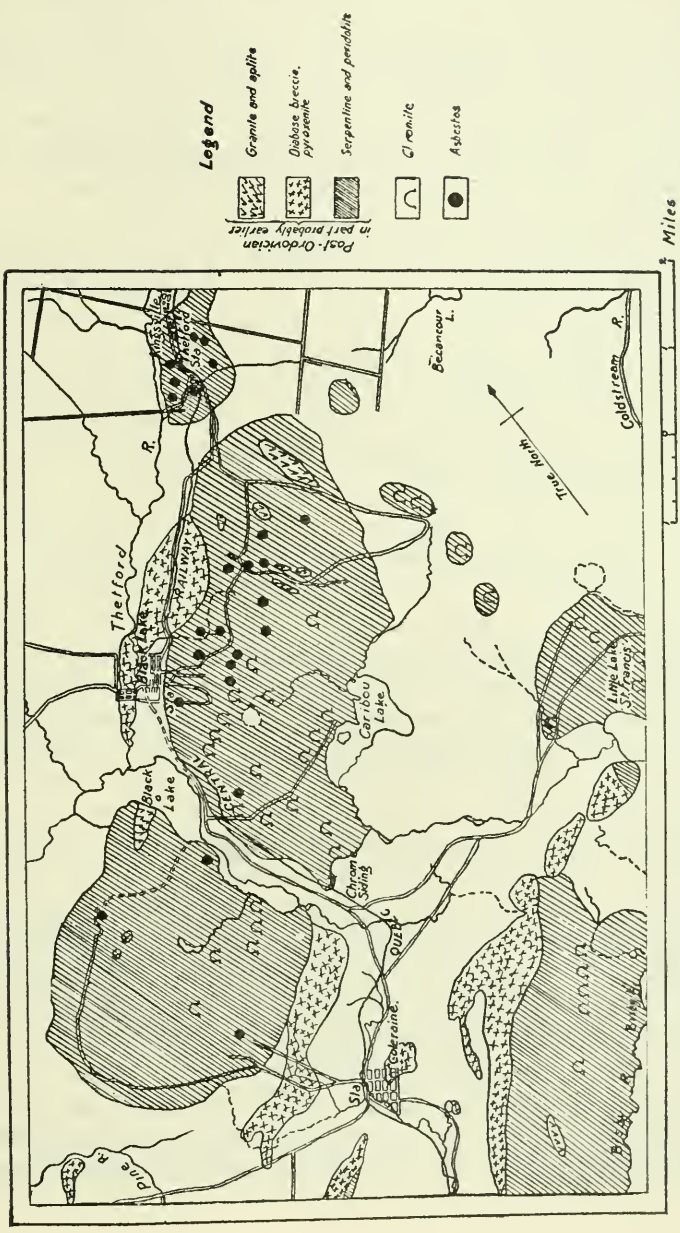
At Black Lake the chief points of interest are: the rock types of the peridotite series; occurrence and relation of asbestos veins; mining and milling of the asbestos-bearing rock; occurrence, mining and milling of chromite ore.

ROCK TYPES OF THE PERIDOTITE SERIES.

Of the rock types of the peridotite series, diabase, porphyrite, peridotite, serpentine and granite are present at Black Lake.

The diabase and porphyrite occur as marginal phases of the peridotite stock at the contact with the sediment, in a few localities the contact being marked by a breccia in which fragments of the sediments are cemented by a paste of the diabase. In general both these rocks have been so much altered that it is only by careful microscopic work that they can be distinguished. Both are now commonly represented by a fine grained chloritic or epidotic rock. In some places typical pillow structure may be observed; at others, the rock has the appearance of a tuff or breccia.

It is difficult, and often impossible, to distinguish peridotite and serpentine in hand specimens. In the field and in mining operations they are collectively called serpentine. The peridotite is composed of olivine, a small amount of pyroxene, and a little chromite and magnetite. The serpentine is merely an altered phase of the peridotite. The mineral serpentine is derived from olivine by hydration accompanied by loss of the iron content. Pyroxene may also alter to serpentine; but it changes less readily than olivine, having



Vicinity of Black Lake and Thetford, showing asbestos and chromite deposits.

originally more silica in its composition, and more frequently it alters to soapstone or talc. The olivine is sometimes completely altered to serpentine, in which case the pyroxene crystals when any are present show as glistening grains, usually $\frac{1}{8}$ inch or less in diameter. On weathered surfaces they stand out in relief, giving a rough surface to the serpentine, like raised nail heads, or knots in a worn floor. This is well shown in the rock near the summits of the serpentine and peridotite hills above Black Lake village.

The granite in this area is composed of feldspar, quartz and hornblende or biotite, or both. It is light grey in colour, and occasionally shows a pinkish tint. Types without hornblende or mica,—principally dykes, are also present, but are more properly classed as aplite. The granite is considered to be the end product of the process of differentiation and nearly contemporaneous with the peridotite. The peridotite retained at least sufficient heat at the time of the intrusion of the granite dykes to enable them to cool without a fine grained border.

OCCURRENCE AND RELATIONS OF ASBESTOS VEINS.

The asbestos is of the chrysotile variety—hydrous silicate of magnesium—and has the same chemical composition as the serpentine which contains it, but is distinguished from it by a fibrous form. The asbestos occurs almost wholly in veins which are usually $2\frac{1}{2}$ inches or less in width, the greater number being less than $\frac{1}{2}$ inch. The fibres lie usually at right angles to the walls of the veins, hence the length of the fibre is limited by the width of the vein; but it rarely equals it, for there is usually a parting in the vein which is marked by a film of iron ore, generally magnetite. The veins are invariably bordered by a band of pure serpentine on either side of the vein, whether the country rock is wholly or partially serpentinized, or even a slightly altered peridotite. These serpentine bands bordering the veins are usually as well defined as the vein itself, and in width are proportionate to it, each being nearly three times the width of the asbestos vein.

From a consideration of these facts, and of the number, size, and directions of the veins, it is believed that they were formed, not by the filling of once open fissures, but by the replacement or

crystallization—more or less perfect—of the pure amorphous serpentine of the side walls. This process is thought to have begun at a fracture, now indicated by the parting or film of iron ore within the vein, and to have extended into the wall rock on one or both sides to a distance proportionate to the width of the serpentine bands. They thus belong to the class of veins sometimes called exogenous or outward growing, as distinguished from those that are formed by filling a fissure from the walls inward. Measurements of many veins show that the proportion of asbestos to the two bands of serpentine is 1 to 6.6, or that approximately 15 per cent. of the serpentine has taken the crystalline form of asbestos.

In the Thetford or later serpentine, many of the larger veins can be seen to follow joint planes in the original rocks. Another class seems to have grown from fractures caused by regional folding, as is indicated by their approximate parallelism. Fractures, produced in early stages of disintegration of the rock by casting off shells from the jointed blocks, give a series of crescent-shaped veins, surrounding a core of peridotite. Where all of these classes of veins are found together, a very intricate network results, but by careful observation many of them can be referred to one or other of these classes.

The determination of other causes of the shattering of the rock, such as hydration, rapid cooling, and, possibly, original gneissic structure near the edge of an intrusion, requires a full investigation covering the entire process of serpentinization.

MINING AND MILLING OF THE ASBESTOS-BEARING ROCK.

All the mines are worked by open-cut methods. The ground at the bottom of the pit is usually cut into a series of benches, generally about 8 to 15 feet (2.4 to 4.5 m.) high, which afford a number of faces from which the rock can be quarried at the same time. At the Bell mine, Thetford, extensive underground work has been carried on in winter with apparent success. Generally, the mines are operated only by day. Several of the pits have reached a depth of about 200 feet (61 m.), with two or three times greater horizontal extension.

In some of the mines the asbestos-bearing portion is separated from the barren rock in the pit, and in part, the "crude" from the mill stuff. A certain amount of hand cobbing is also done in some pits. In most, however, all hand separation is done at the surface. There, the separate products are emptied into tramcars, drawn usually by small locomotive engines; the dead rock is then taken to the waste dump, and the rock which will afford crude asbestos to the cobbing sheds, where it is separated by hand work and put in bags. The remainder, usually 35 to 60 per cent. of all the rock handled, goes to the ore bins, or directly to the mill for mechanical concentration.

Except for minor differences in handling, the principles used in the treatment of the asbestos-bearing rock are the same at all the mills. The dried rock is crushed by stages. The crushing is effected by means of gyratory or jaw crushers, or both, followed by rolls, and then cyclones or jumbos, the particular style of machine employed being largely a matter of the personal taste of the manager. Between each stage of crushing, the material is passed over screens, close above which are the inlets of suction fans by which any fibre is removed. The undersize passes on to the next screens while the oversize is ground further. Partial grading of the asbestos is effected by this removal of the fibre at the various stages in the crushing process, and this grading may be further improved by screening. Magnets are usually employed over the shaking screens to eliminate particles of iron ore.

The milled fibre is separated into three or more grades, and the crude asbestos usually into two.

CHROMITE.

The most important chromite deposits are reached from Black Lake village, but as they all present similar characteristics, the Montreal pit is described as a typical example.

Mode of Occurrence.—The Montreal pit is in a serpentinized peridotite near a contact with diabase,— the latter rock occurring in the opposite slope of the little valley. The ore body consists chiefly of a series of lens-shaped bodies of massive chromite. Assoc-

iated with this is a large quantity of ore consisting of disseminated grains of chromite in the serpentine country rock, sufficiently rich to concentrate.

The whole deposit has been faulted and squeezed to such a degree as to produce an infinite number of slickensided surfaces. For this reason the ore is deceiving, as it tends to break along the film of serpentine in these slickensides so that what may appear to be merely a block of serpentine is in reality massive ore. Cutting the serpentine are several kaolinized granitic dykes, numerous blocks from which are to be found on the dump and some of which contain an unusual pink vesuvianite.

Mining and Milling.—The ore was mined by means of open cuts, and by a drift from the bottom of the main or lower pit. At least 2,200 tons of crude and 500 tons of concentrated ore have been shipped from these workings.

In the method of concentration used, the ore, after preliminary breaking in a jaw crusher, was fed to three batteries of five stamps each. The pulp from each battery passed over a Wilfly table, which gave three products, concentrates, middlings and tails. The middlings from all three tables were treated on a fourth table which produced concentrates and tails. The concentrates after draining were ready for shipment.

The ore was graded, and sold according as the content of chromic oxide was greater or less than 50 per cent. The highest percentage reached was very rarely above 55, and with some ores difficulty was experienced in obtaining even 50 per cent. This last trouble was evidently due to the chromite having an undue amount of Cr_2O_3 replaced by Al_2O_3, so much so that the percentage of Cr_2O_3 remained low even with a very complete removal of the gangue.

Thin sections of some of the ore show it to be composed of an opaque black variety, high in Cr_2O_3, and a reddish, translucent variety containing less Cr_2O_3.

THETFORD.

The visit to Thetford affords further opportunities for the study of the occurrence, mining and milling of asbestos—subjects which have already been discussed for the occurrence at Black Lake.

EAST BROUGHTON.

The interest at East Broughton centres in the rock types, and the occurrence of asbestos in sills.

ROCK TYPES.

The rock differs from that of Thetford and Black Lake, in being much softer and more shattered. It is almost completely serpentinized, the only exception being certain hard blocks which carry no asbestos. The asbestos recovered here rarely occurs in veins, but generally as slip or parallel fibre, being, in fact, only the softer and partially fibrous, outer portions of the individual pieces into which the rock is shattered. A microscopic examination of these rocks is still necessary in order to determine the actual mineral composition of these hard blocks, and to find out, if possible, whether the asbestos-bearing portion was originally similar to that in the Thetford series. The presence of considerable bodies of talc, and steatite or soapstone, indicates that there was a good deal of pyroxene in the original rock. There is very little chromite in the serpentine of this class.

The altered greenstones are chloritic and epidotic schists, probably originally diabase, together with hornblende schists which grade into them. The latter may be the altered, more acid parts of the primary rock, perhaps corresponding to the porphyrite of the Thetford series. The precise character of these rocks can only be determined by detailed lithological examination, which has not yet been made.

The appearance of the rock is at first disappointing as there are no signs of the cross fibre veins which are so much in evidence at Thetford. However, on crushing the rock to a fine powder a considerable amount of short fibre is found. The asbestos produced at East Broughton is all of short fibre and of low grade, no crude whatever being obtained. The fibre appears to lie chiefly along the slipping planes, which are the result of the shattering of the rock into innumerable small pieces by some such cause as swelling during serpentinization, general regional metamorphism, or folding. The rock is much more completely altered than that of the Thet-

ford deposits and now consists almost entirely of serpentine with a certain amount of talc—the latter indicating the impure nature of the original peridotite.

SILLS.

In striking contrast to the deposits at Thetford and Black Lake, which are in the margin of a stock several miles across, the asbestos deposits at East Broughton occur in sill-like bodies. Two pits have been opened to the full width of a sill about 100 feet (30 m.) thick, of which both the foot and hanging walls are exposed. Other smaller parallel sills also occur close at hand. The main sill extends nearly continuously for 6 miles (9.6 km.), five pits having been opened up in this distance. It is also probable that the pits of the Berlin, B. & A., and the Robertson Asbestos Co., 8 miles (12.8 km.) farther on, are in the same sill, so that the sill has a probable length of about 14 miles (22.5 km.)

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